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C O N T E N T

THE MELLIFEROUS BASE IN THE CISNĂDIOARA AREA, SIBIU COUNTY, ROMANIA AND ITS IMPORTANCE IN HONEY PRODUCTION

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Abstract

In order to increase beekeeping, a more detailed research of the honey flora is needed. The purpose that our study undertakes is the identification of plants with honeybee potential in the Cisnădioara area (Sibiu county), as well as the enrichment of knowledge on the honeybee floristic structure of the whole county. To achieve this goal, we used: bibliography, direct sampling of plants, photographs and discussions with local beekeepers. The study was finalized with drawing up a compiling list of plants with a melliferous potential in this zone. 38 botanical families and 117 species with a melliferous potential were identified and arranged into three groups related to their melliferous weight: a high, a medium and a low economical beekeeping weight. The absence of the plants with a very high economical beekeeping weight is highlighted. This fact determines the beekeepers in the studied area, to practice pastoral beekeeping, at large distances, in order to have an important honey production.

Key words*: *plants with melliferous potential, Cisnădioara, Sibiu county, Romania

INTRODUCTION

The Melas-Bee, an amazing and unique creature! In antiquity it was considered a present from the Gods. In the lengthways of time the bee was regarded as being "the one animal sent by Divinity". In England it is said that the history of the bee is the history of mankind. It offered food to Gods and to the people. It was the substance of a mythological cycle known in all Greek world. It followed the human being even beyond death offering mankind the material for embalmment. The golden colour of honey was given as name to the rocks of one Mediterranean Island, that received the nickname "The Island of Honey" (Malta). The bee appears on the currency of some states, as a socio-economical model to be followed. The ethological studies about bees awarded scientists with the Nobel Prize. The bee as a symbol was even imprinted on the Imperial Mantle. The organization and the structure of the bee family was studied by the social sciences further taken as a model by the human society. The bee was and is till this present day a subject for the handbooks, treatises, encyclopaedias. It fascinates the writers who "praise" it in their literary works. The genetics even introduced it for a study of the ginormous. Honey production supports the food, cosmetic and medical- sanitary industries.

A source for legends and myths, the bee accompanied mankind by bringing special moments of peace and serenity. The magic of beekeeping gives the man at the "end" of his career, the feeling of reconciliation with nature and divinity.

The binomial bee-melliferous flora exists since forever meaning since the appearance of the flowering plants, about 200 million years ago [9]. Since then, it proceeds under the "sine qua non" meaning under the reciprocity sign. The melliferous flora offers the bee the raw material in return the bee offers pollination to the flora. One without the other would not exist.

The abundance of the flora in our country, inspired Pope John Paul the II-nd to call it: "The Holy Virgin's Garden".

As early as antiquity, Herodot mentioned that the lands beyond the Istru cannot be easily crossed because of the swarm of bees. Therefore, the abundance of the melliferous plants is asserted. This fact is confirmed by Xenophon and later by the geographer and historian Polibius of Megalopolis and by the naturalist Claudius Aelianus. Also, Xenophon mentioned that the food of Getas consisted primarily of honey, vegetables, and milk products [8]. Nowadays, on the territory of Romania country are more than 11 million ha. with melliferous flora that assure the existence of more than 1.7 million bee families. These have at their disposal both the agricultural surfaces and forests, grasslands, and hay fields [1]. Beekeepers remarked the fact that bees prefer the melliferous flora that contains the principles of the medicinal flora.

The quality of honey from our flora was always appreciated on European level, and it incited the interest of coterminous imperial countries and commercial traders alike.

The present study has as purpose the identification of the melliferous flora from Cisnădioara area and the completion of the data base regarding the melliferous potential of the flora in Sibiu County. Currently, the plants with melliferous potential are studied, known, protected, and cultivated more on larger surfaces. These achievements lead to the knowledge and the conservation of the biodiversity, that implies the important of harvests and production.

MATERIALS AND METHODS

The research was carried out in Cisnădioara and its surroundings (Sibiu county), 10 km away from Sibiu municipality. The settlement is situated on a slope of the Subcarpathian hills, with a rich vegetation. The studied area presents both advantages and drawbacks.

1. Some advantages are: the presence of the forests near the settlement. This represents, during the springtime, an important source of pollen. After the exhaustion of this source, the cherry tree blossoms (*Cerasus avium* L.) and the hawthorn (*Crataegus monogyna* Jacq.) as well. At the same time the hayfields flora blossoms. All these harvests are good for the maintenance and development of the bee families and their preparation for the next important harvest.
2. The drawbacks in this area consists in a high number of beehives and the proximity of hearths belonging to the owners as a result of the land ownership right. Thus, there are sometimes deficiencies in the optimal load of a bee family per unit area and animosity among beekeepers. The current norms recommend 100 bee families per 5 km^2, unlike in the studied area where the number of bee families exceeds 5 times the norm [10].
3. Another problem faced by beekeepers in the area is the intense spraying on farms that does not take into account the location of the hearths.

The study of the melliferous flora was carried out in two major parts:

-The first and most important was the use of data from specialized literature.

-The second part implied the field research, observation and identification of melliferous species; collection of melliferous plants; taking photos and additional discussions with the beekeepers from area were led.

-The study was carried out during the period 2019-2020;

-Resources from specialized literature contributed in the identification of the flora in the laboratory [2, 7, 11-15, 20].

RESULTS AND DISCUSSIONS

The beekeepers in order to obtain a rich and diversified production must apply in the apiary a set of modern technologies for breeding and developing of the bee families. Moreover they must be connoisseurs of the melliferous plants thus recognising their specific features and qualities. Cisnădioara is a part of the 30 localities in Sibiu County that have been very well investigated concerning their botanical features disposing of an almost complete inventory of flora made by researchers from the Natural History Museum in Sibiu and their collaborators [3-5, 16-19].

After the floristic study in this area, based on the specialized literature and own observations in the field, 72 families of plants with 526 species were identified. Containing a melliferous potential in the Cisnădioara areal only 117 taxons in 38 botanical families were highlighted (Table 1).

Table 1. The melliferous potential of the flora from Cisnădioara

Nr. crt.	Family	Species	Beekeeping weight
1	Cupressaceae	*Juniperus communis* (L.)	Little
2	Berberidaceae	*Berberis vulgaris* (L.)	Medium
3	Ranunculaceae	*Anemone ranunculoides* (L.)	Medium
4		*Caltha palustris* (L.)	Medium
5		*Clematis vitalba* (L.)	Medium
6	Papaveraceae	*Chelidonium majus* (L.)	Little
7		*Corydalis solida* (L.)	Medium
8		*Chelidonium majus* (L.)	Little
9		*Corydalis solida* (L.)	Medium
10	Fagaceae	*Fagus sylvatica* (L.)	Medium
11		*Quercus petrea* (Mattuschka)	Medium
12		*Quercus robur* (L.)	Medium
13	Betulaceae	*Alnus glutinosa* (L.)	Medium
14		*Alnus incana* (L.)	Medium
15	Corylaceae	*Corylus avellana* (L.)	Medium
16	Polygonaceae	*Polygonum aviculare* (L.)	Little
17	Rosaceae	*Cerasus avium* (L.)	Medium
18		*Crataegus monogyna* (Jacq.)	Medium
19		*Filipendula ulmaria* (L.)	Medium
20		*Filipendula vulgaris* (Moench.)	Little
21		*Fragaria vesca* (L.)	Little
22		*Fragaria viridis* (Weston)	Medium
23		*Potentilla alba* (L.)	Little
24		*Potentilla reptans* (L.)	Little
25		*Prunus spinosa* (L.)	Medium
26		*Rosa arvensis* (Hudson)	Medium
27		*Rosa canina* (L.)	Medium
28		*Rubus idaeus* (L.)	Large
29		*Sorbus aucuparia* (L.)	Medium
30	Fabaceae	*Lotus corniculatus* (L.)	Medium
31		*Medicago falcata* (L.)	Medium
32		*Medicago lupulina* (L.)	Medium
33		*Trifolium campestre* (Schreber)	Medium
34		*Trifolium dubium* (Sm.)	Medium
35		*Trifolium medium* (L.)	Medium
36		*Trifolium pannonicum* (Jacq.)	Medium
37		*Trifolium pratense* (L.)	Medium
38		*Trifolium repens* (L.)	Large
39		*Vicia sepium* (L.)	Medium
40	Thymelaeaceae	*Daphne mezereum* (L.)	Medium
41	Cornaceae	*Cornus sanguinea* (L.)	Medium
42	Rhamnaceae	*Frangula alnus* (Miller)	Medium
43		*Rhamnus cathartica* (L.)	Medium
44	Aceraceae	*Acer campestre* (L.)	Medium
45		*Acer platanoides* (L.)	Medium
46		*Acer pseudoplatanus* (L.)	Medium
47	Geraniaceae	*Geranium pratense* (L.)	Medium
49	Apiaceae	*Angelica sylvestris* (L.)	Medium
50		*Anthriscus cerefolium* (L.)	Little
51		*Astrantia major* (L.)	Little
52		*Chaerophyllum aromaticum* (L.)	Little
53		*Daucus carota* (L.)	Medium
54		*Heracleum sphondyllium* (L.)	Little
55		*Pimpinella saxifraga* (L.)	Little
56	Tiliaceae	*Tilia platyphyllos* (Scop.)	Large
57	Violaceae	*Viola ambigua* (Waldst. et Kit.)	Medium
58		*Viola canina* (L.)	Medium
59		*Viola adorata* (L.)	Medium
60	Brassicaceae	*Cardamine pratensis* (L.)	Little
61		*Lunaria rediviva* (L.)	Medium
62	Resedaceae	*Reseda lutea* (L.)	Medium
63	Salicaceae	*Populus tremula* (L.)	Medium
64		*Salix caprea* (L.)	Large
65		*Salix cinerea* (L.)	Large
66	Ericaceae	*Vaccinium myrtillus* (L.)	Medium
67		*Vaccinium vitis-idaea* (L.)	Medium
68	Primulaceae	*Primula veris* (L.)	Medium
69	Apocynaceae	*Vinca minor* (L.)	Little
70	Oleaceae	*Fraxinus excelsior* (L.)	Medium
71		*Ligustrum vulgare* (L.)	Medium
72	Boraginaceae	*Cerinthe minor* (L.)	Medium
73		*Echium vulgare* (L.)	Little
74		*Myosotis sylvatica* (Ehrh.)	Medium
75	Verbenaceae	*Verbena officinalis* (L.)	Medium
76	Lamiaceae	*Ballota nigra* (L.)	Medium
77		*Glechoma hederacea* (L.)	Medium
78		*Glechoma hirsuta* (Waldst.)	Medium
79		*Lamium album* (L.)	Medium
80		*Lamium maculatum* (L.)	Medium
81		*Leonurus cardiaca* (L.)	Medium
82		*Melittis melissophyllum* (L.)	Medium
83		*Mentha arvensis* (L.)	Large
84		*Mentha longifolia* (L.)	Medium
85		*Origanum vulgare* (L.)	Medium
86		*Prunella vulgaris* (L.)	Medium
87		*Salvia verticillata* (L.)	Medium
88		*Stachys germanica* (L.)	Medium
89		*Stachys sylvatica* (L.)	Medium
90		*Teucrium chamaedrys* (L.)	Medium
91		*Thymus glabrescens* (Willd.)	Medium
92	Scrophulariaceae	*Linaria vulgaris* (Miller)	Medium
93		*Scrophularia nodosa* (L.)	Medium
94		*Verbascum lychnitis* (L.)	Medium
95		*Verbascum phlomoides* (L.)	Medium
96		*Veronica officinalis* (L.)	Medium
97		*Veronica orchidea* (Crantz)	Little
98	Rubiaceae	*Galium verum* (L.)	Little
99	Caprifoliaceae	*Viburnum lantana* (L.)	Medium
100	Valerianaceae	*Valeriana officinalis* (L.)	Medium
101	Dipsacaceae	*Scabiosa ochroleuca* (L.)	Medium
102	Asteraceae	*Arnica montana* (L.)	Little
103		*Bellis perennis* (L.)	Medium
104		*Centaurea jacea* (L.)	Medium
105		*Cichorium intybus* (L.)	Medium
106		*Echinops sphaerocephalus* (L.)	Medium
107		*Eupatorium cannabinum* (L.)	Medium
108		*Inula conyza* (DC.)	Little
109		*Solidago virgaurea* (L.)	Medium
110		*Taraxacum officinale* (Weber)	Medium
111		*Tussilago farfara* (L.)	Little
112	Liliaceae	*Gagea lutea* (L.) Ker.-Gawl.	Medium
113		*Lilium martagon* (L.)	Medium
114		*Ornithogalum umbellatum* (L.)	Medium
115	Amaryllidaceae	*Galanthus nivalis* (L.)	Medium
116	Orchidaceae	*Orchis morio* (L.)	Medium
117		*Orchis ustulata* (L.)	Medium

The source: [5].

Three botanical categories are highlighted by the analysis of the data from Table 1 concerning the number species/families:

-Well represented botanical families are: *Lamiaceae* with 16 species, *Rosaceae* 13 species, *Fabaceae*, and *Asteraceae* with 10 species, *Apiaceae* 7 species, *Scrophulariaceae* with 6 species, *Papaveraceae* with 4 species.

-The botanical families represented by a small number of species are: *Ranunculaceae*, *Fagaceae*, *Aceraceae*, *Violaceae*, *Salicaceae*, *Boraginaceae*, *Liliaceae* each of them with 3 species; *Betulaceae, Rhamnaceae, Brassicaceae, Ericaceae, Oleaceae, Orchidaceae* with 2 species per family.

-The botanical families represented only by a single species: *Cupressaceae, Berberidaceae, Corylaceae, Polygonaceae, Thymelaeaceae, Cornaceae, Geraniaceae, Tiliaceae, Resedaceae, Primulaceae, Apocynaceae, Verbenaceae, Rubiaceae, Caprifoliaceae, Valerianaceae, Dipsacaceae, Amaryllidaceae* (Table 2).

Table 2. The list of botanical families, the numerical and relative abundance of the species with a melliferous potential in the Cisnădioara area (Sibiu County)

Nr. crt.	Family	the numerical Abundance	the relative Abundance (%)
1	*Cupressaceae*	1	0,85
2	*Berberidaceae*	1	0,85
3	*Ranunculaceae*	3	2,56
4	*Papaveraceae*	4	3,41
5	*Fagaceae*	3	2,56
6	*Betulaceae*	2	1,70
7	*Corylaceae*	1	0,85
8	*Polygonaceae*	1	0,85
9	*Rosaceae*	13	11,11
10	*Fabaceae*	10	8,54
11	*Thymelaeaceae*	1	0,85
12	*Cornaceae*	1	0,85
13	*Rhamnaceae*	2	1,70
14	*Aceraceae*	3	2,56
15	*Geraniceae*	1	0,85
16	*Araliaceae*	1	0,85
17	*Apiaceae*	7	5,98
18	*Tiliaceae*	1	0,85
19	*Violaceae*	3	2,56
20	*Brassicaceae*	2	1,70
21	*Resedaceae*	1	0,85
22	*Salicaceae*	3	2,56
23	*Ericaceae*	2	1,70
24	*Primulaceae*	1	0,85
25	*Apocynaceae*	1	0,85
26	*Oleaceae*	2	1,70
27	*Boraginaceae*	3	2,56
28	*Verbenaceae*	1	0,85
29	*Lamiaceae*	16	13,67
30	*Scrophulariaceae*	6	6,12
31	*Rubiaceae*	1	0,85
32	*Caprifoliaceae*	1	0,85
33	*Valerianaceae*	1	0,85
34	*Dipsacaceae*	1	0,85
35	*Asteraceae*	10	8,54
36	*Alliaceae*	3	2,56
37	*Amaryllidaceae*	1	0,85
38	*Orchidaceae*	2	1,70
Total		117	100%

Source: Own calculation.

The beekeeping weight of each honey plant is given by the harmony of a number of factors including: the time and duration of flowering, nectar-pollinating effectiveness, the extent of the land occupied by each taxon, whether it is part of the wild or cultivated flora [6]. The analysis of this complex of factors on the territory of our country determined the grouping of melliferous resources in terms of importance for beekeeping in: very high beekeeping plants, high beekeeping plants, medium beekeeping plants, low beekeeping plants, plants without economic-beekeeping weight.

The total of 117 species of plants with a melliferous potential in Cisnădioara area and surroundings are divided into three groups:

-The species with a high economical beekeeping weight and a high melliferous potential: *Rubus idaeus* (L.), *Trifolium repens* (L.), *Tilia platyphyllos* (Scop.), *Salix caprea* (L.), *Salix cinerea* (L.), *Mentha arvensis* (L.). These 6 species (5%) can provide in the area periodically or annually the production harvest.

- The best represented category is the one with a medium economic weighting. The 90 species (79%) in this group provide significant nectar and pollen harvests.

- The third group is represented by 21 taxa (16%) with low economic value.

Plants with honey potential in the first 2 groups have obvious implications in beekeeping and are important for bees, providing annual or regular honey crops. In the area, the harvest is provided mainly by hayfields. Maintenance harvests are provided by trees, shrubs and herbaceous vegetation, especially in spring and early summer.

The most important category from economical point of view is missing meaning the plants with a very high economical weight, that yearly provide important harvests.

For the realization of large productions, the beekeepers from the area practice the pastoral beekeeping at the raspberry honey massifs. In recent years, but especially in the period 2019 - 2020, climate change has determined beekeepers in the area to practice long-distance pastoral beekeeping in the counties: Dolj, Mehedinți, Gorj, Argeș and Vâlcea, for acacia harvesting, in Tulcea county for harvesting linden trees and in Constanța county for sunflower harvesting.

CONCLUSIONS

The study of flora in the areas of Cisnădioara, confirms the fact that this area is well studied from a botanical point of view and presents an almost complete a floristic inventory.

In the studied area 526 taxon's were found, out of which only 117 taxon's (22,24%) present a melliferous potential.

The inventory of flora with a melluferous potential contains 38 botanical families. The best represented is the family *Lamiaceae* (16 species), followed by *Rosaceae* (13 species), *Fabaceae* and *Asteraceae* (10 species, each of them), *Apiaceae* (7species), *Scrophulariaceae* (6 species), *Papaveraceae* (4 species).

At the opposite pole, 17 families have only one single representative: *Cupressaceae, Berberidaceae, Corylaceae, Polygonaceae, Thymelaeaceae, Cornaceae, Geraniceae, Tiliaceae, Resedaceae, Primulaceae, Apocymaceae, Verbenaceae, Rubiaceae, Caprifoliaceae, Valerianaceae, Dipsacaceae, Amaryllidaceae*.

From the importance point of view for beekeeping, only two categories were identified: 6 species (5%) with a high economical beekeeping weight and 90 species (79%) with a medium economical beekeeping weight. Only species with a high beekeeping weight can ensure the production, periodically or annually, in the area. Due to an accumulation of natural factors (climate change, deficit of species with very high honey potential), but also anthropogenic (too many hives in the area, very close permanent hearths, which endanger the production of honey and other bee products, endangering and bee families) motivate beekeepers in the area to practice pastoral beekeeping in order to obtain significant production harvests.

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UTILIZATION OF PULSE SPRINKLER TECHNIQUE FOR FLAX FIBER EXTRACTION

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Abstract

This study was performed to assess flax fiber extraction by pulse sprinkler technique compared with traditional method (submerged). For this purpose, an experiment was performed in fiber crops research department, Gemmiza Research Station, Gharbeiah Governorate, middle of the Nile Delta, Egypt during September and October, 2019. The micro-sprinkler system was applied with four values of pulses at cycle ratio of ½ namely (one, two, three and four) under two fiber extraction environment conditions (open field and in greenhouse) and two flax varieties Sakha 3 and Giza 12 were applied. The results showed that fiber extraction by T_G treatments saved applied water and increased fiber yield rate, fiber length and water productivity comparing with T_F treatments and T_W. T_{F4} and T_{G4} saved applied water comparing with T_W by about 17.2 and 25.2 % respectively for Sakha 3 and by about 28.7 and 34.5 % for Giza 12. T_W increased fiber yield rate more than T_{F4} for two varieties Sakha 3 and Giza 12 by 2.6 and 5.3 % respectively, while decreased fiber yield rate less than T_{G4} by 2.9 and 6.0 % for two varieties respectively. The highest fiber length achieved by T_W and T_{G4} with value of 90.0 cm for variety Sakha 3 and by T_{G4} with value of 87.0 cm for variety Giza 12. T_{G4} had the highest water productivity with values of 27.5 and 21.2 kg/m^3 for two varieties Sakha 3 and Giza 12 respectively.

Key words: *pulse, fiber yield, water productivity, applied water*

INTRODUCTION

Fiber extraction process is defined separating the fibers from non-fiber tissues in stalks also separating the fibers from each other. There are many methods to extract fibers for example steam explosion, enzymes retting, osmosis, electrolysis and redox pretreatment. But due to restriction such as high maintenance costs and environmental safety criteria it may is hard to apply these methods [19]. In Egypt the flax straw is submerged with water about 24 h then the water was drained. This operation repeated every day through 4 to 7 days for leaching out the soluble materials. Retting process is considered the main problem in extracting flax fibers [15]. In Europe water retting replaced by dew retting; stalks are distributed in the field and attacked by pectinolytic enzymes which excreted by fungi. In spite of dew retting cheaper but it has many negatives as high labor costs, takeover agricultural land for many weeks, differences in fiber quality caused by uncontrollable factors as moisture, temperature and activity of the microbial flora [11]. Water retting take less time and produces superior quality fiber comparing with dew retting, but it consumes large amount of water and retting liquor can cause contamination of ground water if it is not treated properly before discharging [2] and [17]. To overcome the problems of traditional retting methods (water and dew) new methods especially enzyme retting are being pursued [3]. Separation of fibers from stalks involves the degumming it in a water environment in a chemical, physical or biological process [5]. Effect of chemical, water, microbiological and enzymatic extraction methods on fiber quality of stalk nettle was evaluated and compared. Microbiological method unlike expected did not minimize the extraction time in comparison with traditional water method. Generally microbiological and enzymatic methods improved fiber quality comparing with traditional water method [7]. Extraction of the fibers from fibrous plants involves the degumming of stalk in an aqueous environment where biological, chemical or physical processes take place [12]. The method of extracting fibers is one of the important factors that quality of fibers depends on it, thus it is essential to sequence studies to introduce new retting methods more eco-friendly, short time, save water and produce superior quality fibers [13]. Impact of dew retting and osmotic degumming on bast fiber properties was investigated. The results proved that osmotic degumming improved significantly the fiber quality comparing with dew retting [14]. Traditional chemical degumming causes critical fiber damage and also consider an environmental risk, so it is fundamental to find a new chemical degumming method to overcome these disadvantages [10].

In previous work sprinkler system was applied for extraction flax fibers (called sprinkler retting) to overcome disadvantages of water retting in Egypt. Sprinkler retting consumed less water, improved fiber fineness and more eco-friendly where no odor and less labor; but it was not increase fiber percentage or fiber length and take more time ranged from (14 -24) days [6]. It is not necessary to immerse the flax straw with water for several days to obtain a successful fiber extraction process as it happen in traditional method, but it is possible to use the sprinkler network for extracting the fibers where the straw is wetted for a certain period daily which stimulates the activity of retting bacteria. With the daily addition of water the bacterial activity continues and the fiber extraction process takes place thus, the benefit of added water can be maximized. Intermittent irrigation is modern technique to manage irrigation systems and has been studied in many articles. It has been used since the 1980s with surface irrigation and called surge irrigation; recently it was applied with pressurized irrigation systems under the name of pulse irrigation. Surge/pulse irrigation is defined as 'the intermitted application of irrigation water to soil surface, creating series of on/off intervals at constant or variable time [20]. Sprinkler irrigation performance depend on main two factors; design factors include (sprinkler type and height, single or double nozzles, nozzle diameters and sprinklers overlapping) and operation factors include (operating pressure, irrigation duration and environmental conditions) [16] and [4]. Square layout increased uniformity and decreased the average of wind drift and evaporation losses comparing with rectangular layout [18]. To enhance distribution uniformity and water application efficiency the sprinkler irrigation system must be manage correctly, maintain regularly and operate at the design operating pressure [8]. Performance of mini-sprinkler irrigation system with nozzle sizes ranged from 0.85 to 2.0 mm under operating pressure ranged from 0.5 to 3.0 bar was evaluated. The results concluded that for all tested nozzle sizes increasing operating pressure from 0.5 to 2.0 bar increased uniformity coefficient; after that uniformity decreased [22]. The factors that affect sprinkler irrigation distribution uniformity are divided into three main factors; design factors such as sprinkler characteristics (number of nozzles, size and shape), operating pressure and sprinkler spacing; environmental factors such as humidity and more importantly wind direction and speed and management factors such as irrigation duration, time of day irrigation is performed and practicing of offsetting laterals [1] and [9]. The spatial distribution of irrigation water in sprinkler irrigation system based on; design properties, meteorological factors and crop canopy construction [21].

The present research was designed to: (1) evaluate the appropriateness of pulse sprinkler technique for extracting flax fibers comparing with traditional/water method, (2) evaluate the effect of extracting fibers under different environmental conditions on total applied water and fiber yield rate.

MATERIALS AND METHODS

Experimental layout

This study was performed in Gemmiza Research Station, Gharbeiah Governorate, middle of the Nile Delta, Egypt (31°07′ longitude and 30°43′ latitude and altitude 20 m above sea level) during September and October, 2019. Air temperature (max. and min.) relative humidity and wind speed for experiment period were obtained from Agricultural Research Center, EL-Giza, Egypt (Fig. 1).

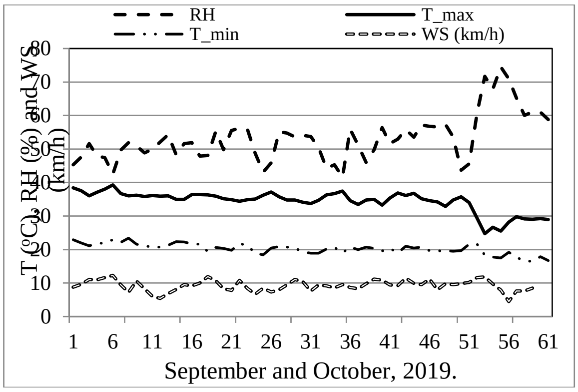

Fig. 1. Maximum and minimum air temperature (°C), relative humidity (RH, %) and wind speed (WS, km/h) for September and October, 2019.
Source: Own calculation.

Properties of irrigation water of the experimental site were analyzed by Soil Sciences Department, Faculty of Agriculture, Kafrelsheikh University, Egypt (Table 1).

Table 1. Some Properties of irrigation water from open channel for experimental site.

Properties	concentration
Potential of hydrogen, (PH)	7.38 mg.l^{-1}
Electrical conductivity, (EC,)	717 mg.l^{-1}
Total dissolved solids, (TDS)	198 mg.l^{-1}
Ammonia, (NH_3)	0.012 mg.l^{-1}
Nitrite, (NO_2)	0.022 mg.l^{-1}
Nitrate, (NO_3)	0.68 mg.l^{-1}
Biological oxygen demand, (BOD)	2.5 mg.l^{-1}
Total suspended solids, (TSS)	99 mg.l^{-1}
Dissolved oxygen, (DO)	3.0 mg.l^{-1}
Total count of bacteria	3.6 X10^5 cfu/ml

mg.l^{-1}: milligram per litter.
cfu = colony forming unit
Source: Own calculation.

Preparation of flax straw bundles

Flax varieties Sakha 3 and Giza 12 were grown in winter season 2018/2019 in Gemmeiza Research Farm, Agricultural Research Center (ARC), Egypt. All agronomic practices were accomplished according to agricultural recommendations for flax. Flax was pulled manually in April, 2019 and dried for several days in open field and seeds were separated mechanically. The straw was stored inside protected sheds to inhibit any effect by indigenous micro-organisms. Before starting fiber extraction process directly straw was packed into initial bundles weighing 500g/bundle; every 30 initial bundles were collected in main bundle with 0.7 m diameter. The main bundle was installed vertically in the distance between sprinklers. Traditional retting was carried out using 8inch (20.32 cm) outer diameter and 130 cm height polyvinyl chloride (PVC) pipes; three initial bundles (500g/bundle) were submerged with water into the pipes. For all the treatments, extraction process stopped when all pectin materials were dissolved. The bundles were dried in open field; the woody materials were broken away machinery to form cellulose fibers.

Micro-sprinkler network

Components of micro-sprinkler network are summarized in Table 2.

Table 2. Components of micro-sprinkler network

Items	Specifications
Control unit	Centrifugal pump (30 m^3/h nominal discharge and 3 "inlet and outlet diameters) powered by 3.75kW internal combustion engine (four-stroke, single-cylinder, Gasoline engine), control valve prevention device, pressure gauges and flow-meter.
Lines :	
Main line	Aluminium pipes with 75 mm outer diameter,70 mm inside diameter and 6 m in length; the pipes connected together by quick couple with rubber ring jointing.
Sub-main lines	Poly Vinyl Chloride (PVC) pipes with 32 mm outer diameter connected with main line by PVC saddles (75 × 32 mm) and 32 mm control valves.
Laterals	Poly Ethylene (PE) pipes with 16mm outer diameter connected with manifold lines by PVC saddles (32 × 16 mm) and 16 mm control valves.
Sprinklers	Rotator micro-sprinkler with 110 l/h flow rate, 2.5 m wetted radius at15 m operating pressure head. The sprinklers joined to lateral lines by 8 mm outer diameter spaghetti tube and fixed on 120 cm stake height.

Source: Own description.

Sprinklers were arranged in square layout, 100% overlapping and operated for two hours daily for all treatments.
Hydraulic performance terms of relationship between operating pressure head (m), flow rate (l/h) and radius of throw (m) was evaluated (Fig. 2).

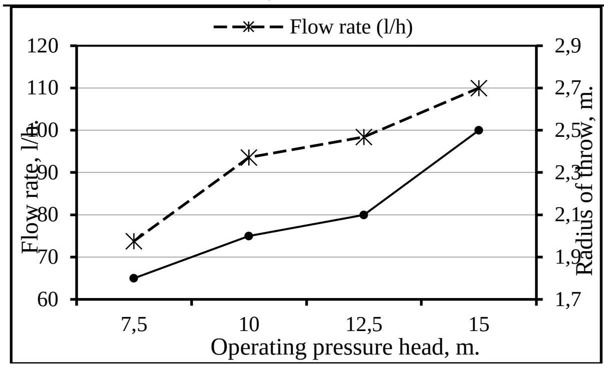

Fig. 2. Relationship between operating pressure head (m), flow rate (l/h) and radius of throw (m) for rotator micro-sprinkler
Source: Own calculation.

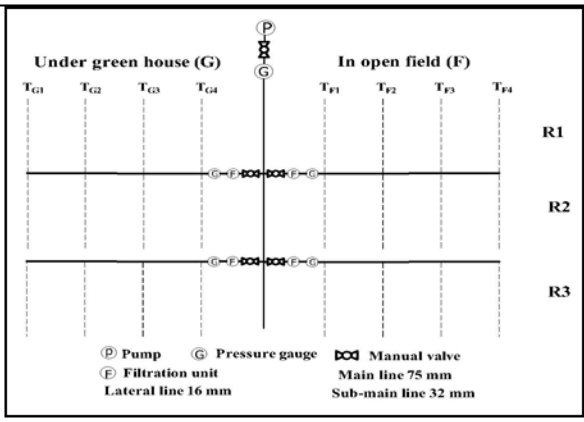

Fig. 3. The experimental field layout and the treatments distribution
Source: Own calculation.

Study variables

a) Fiber extraction environment: two different environment conditions were applied to extract fibers; in open field (F) and under greenhouse (G).

b) Fiber extraction method: pulse sprinkler technique with four numbers of pulses at cycle ratio of ½ was applied; one pulse (continuous; 1), two pulses (2), three pulses (3) and four pulses (4).

c) Flax variety: two varieties Sakha 3 and Giza 12 were used.

Water/Submerged retting (W) was applied as a traditional fiber extraction method. The abbreviations of different treatments are shown in Table 3.

Table 3. The symbols of different treatments

No	Symbol	Treatment
1	T_{F1}	Extraction in open field by one pulse
2	T_{F2}	Extraction in open field by two pulses
3	T_{F3}	Extraction in open field by three pulses
4	T_{F4}	Extraction in open field by four pulses
5	T_{G1}	Extraction under greenhouse by one pulse
6	T_{G2}	Extraction under greenhouse by two pulses
7	T_{G3}	Extraction under greenhouse by three pulses
8	T_{G4}	Extraction under greenhouse by four pulses
9	T_W	Extraction by water/submerged method

Source: Own calculation.

Experimental field layout and treatments distribution are shown in Fig. 3.

Nine experimental treatments for every flax variety were arranged in randomized complete block design with three replicates. The statistical analysis was carried out by Co-Stat program for windows. Least significant difference (LSD) at 5% significance level was carried out to compare the means of different treatments.

Measurements

Total applied water: Total applied water for every treatment from beginning of fiber extraction process until the end of it was calculated and related to ton of flax straw (m^3/ton $_{straw}$).

Fiber yield rate: It was calculated using following equation:

$$F = (Y^{\backslash}/Y)\ x\ 100$$

where:
F = the fiber yield rate
$Y^{\backslash}$ = the final weight of fiber after retting process (g)
Y = the initial weight of straw sample, 500g.

Flax fiber length: Average length for 20 fiber ribbons from each replication were measured and the average for each treatment were recorded

Fiber water productivity: It was calculated for ton of straw using following equation:

$$WP = Y_f/W$$

where:
WP = the fiber water productivity, kg_{fiber}/m^3
Y_f = the total fiber yield, kg
W = the total applied water for ton of straw, m^3.

RESULTS AND DISCUSSIONS

Total applied water

The total applied water (m^3/ton $_{straw}$) for two flax varieties Sakha 3 and Giza 12 in relation to fiber extraction method and environment are listed in Table 4. Analysis of variance referred to high significant difference between treatments. T_W treatment had the highest effect in applied water while T_{G4} treatment had the lowest effect for two varieties Sakha 3 and Giza 12. The total applied water was affected by fiber extraction method and environment. Using sprinkler method decreased applied water comparing with traditional method; this result was in agreement with that resulted by [6]. At sprinkler method; pulse technique decreased applied water comparing with continuous technique. Fiber extraction under greenhouse recorded lowest applied water comparing with fiber extraction in open field; this is may be due to the presence of saturated environment with moisture around the clock by greenhouses. For sprinkler system, using intermittent technique helps to minimize evaporation losses from the straw surface, thus increasing number of pulses from one to four decreased total applied water at two environment conditions. Two pulses treatments saved water comparing with one pulse (continuous) by 3.7 and 3.2 % at two environment conditions open field and greenhouse respectively for variety Sakha 3 and by 10.2 and 5.6 % respectively for variety Giza 12. Three pulses treatments saved water comparing with two pulses by 7.4 and 7.2 % at two environment conditions respectively for variety Sakha 3 and by 6.6 and 8.8 % for variety Giza 12. Four pulses treatments saved water comparing with three pulses by 5.0 and 7.5 % at two environment conditions respectively for variety Sakha 3 and by 9.7 and 7.3 % for variety Giza 12. Extraction the fibers under greenhouse saved applied water comparing with extraction in open field at different number of pulses from one to four as fallow: Sakha 3 (7.8, 7.3, 7.1 and 9.5) % and Giza 12 (12.0, 7.4, 9.5 and 8.0) %. The lowest applied water was 7.49 and 7.91 m^3/ton $_{straw}$ for two varieties Sakha 3 and Giza 12 which resulted at T_{G4} treatments; while the highest applied water was 10.01 and 12.07 m^3/ton $_{straw}$ for two varieties which resulted at T_W treatments. T_{F4} and T_{G4} treatments saved applied water comparing with water/submerged retting T_W by about 17.2 and 25.2% respectively for Sakha 3 and by about 28.7 and 34.5% for Giza 12. The results indicated to that; design factors, operating factors and weather conditions are specific factors that affect the performance of sprinkler system in extracting the fibers under any environment conditions.

Table 4. Total applied water (m^3/ ton $_{straw}$) and compare means for two flax varieties under different fiber extraction methods and environments

Treatment		Total applied water (m^3/ ton $_{straw}$)	
		Sakha 3	Giza 12
1	T_{F1}	9.78 ^{b}	11.25 ^{b}
2	T_{F2}	9.42 ^{c}	10.10 ^{c}
3	T_{F3}	8.72 ^{e}	9.43 ^{d}
4	T_{F4}	8.28 ^{f}	8.60 ^{e}
5	T_{G1}	9.02 ^{d}	9.90 ^{cd}
6	T_{G2}	8.73 ^{e}	9.35 ^{d}
7	T_{G3}	8.10 ^{g}	8.53 ^{e}
8	T_{G4}	7.49 ^{h}	7.91 ^{f}
9	T_W	10.01 ^{a}	12.07 ^{a}
$LSD_{0.05}$		*0.08*	*0.61*

The same letters indicated not significantly different at 0.05 level
Source: Own calculation.

Fiber yield rate

The fiber yield rate (%) in relation to fiber extraction method and environment for two varieties Sakha 3 and Giza 12 are listed in Table 5. Analysis of variance showed high significant difference in fiber yield rate between different treatments. Comparing means showed that T_{G4} treatment had the highest effect in fiber yield rate with values of 20.6 and 16.8 % for two varieties Sakha 3 and Giza 12 respectively; while T_{F1} treatment had the lowest effect with values of 17.8 and 13.4 % for two varieties respectively. Using pulse sprinkler technique magnify fiber yield rate comparing with traditional method. Fiber extraction under greenhouse improved fiber yield rate comparing with fiber extraction in open field; where the greenhouse provides saturated and regularly environment all the time. Adding the water by pulse technique helps the straw to absorb the moisture and distribute regularly, thus increasing number of pulses from one to four enhance fiber yield rate. At sprinkler retting; two pulses treatment produced fiber yield rate more than one pulse (continuous) as fallow: for Sakha 3 ($T_{F2} > T_{F1}$ = 2.2 % and $T_{G2} > T_{G1}$ = 3.3 %) and for Giza 12 ($T_{F2} > T_{F1}$ = 3.0 % and $T_{G2} > T_{G1}$ = 0.0 %). Two pulses treatment produced fiber yield rate more than one pulse (continuous) as fallow: for Sakha 3 ($T_{F2} > T_{F1}$ = 2.2 % and $T_{G2} > T_{G1}$ = 3.3 %) and for Giza 12 ($T_{F2} > T_{F1}$ = 3.0 % and $T_{G2} > T_{G1}$ = 0.0 %). Three pulses produced fiber yield rate more than two pulses as fallow: for Sakha 3 ($T_{F3} > T_{F2}$ = 3.3 % and $T_{G3} > T_{G2}$ = 5.9 %) and for Giza 12 ($T_{F3} > T_{F2}$ = 2.2 % and $T_{G3} > T_{G2}$ = 7.1 %). Four pulses produced fiber yield rate more than three pulses as fallow: for Sakha 3 ($T_{F4} > T_{F3}$ = 3.7 % and $T_{G4} > T_{G3}$ = 4.6 %) and for Giza 12 ($T_{F4} > T_{F3}$ = 6.4 % and $T_{G4} > T_{G3}$ = 12.0 %).

Table 5. Fiber yield rate (%) and compare means for two flax varieties under different fiber extraction methods and environments

Treatment		Fiber yield rate (%)	
		Sakha 3	Giza 12
1	T_{F1}	17.8 ^{i}	13.4 ^{d}
2	T_{F2}	18.2 ^{g}	13.8 ^{d}
3	T_{F3}	18.8 ^{e}	14.1 ^{cd}
4	T_{F4}	19.5 ^{d}	15.0 ^{bc}
5	T_{G1}	18.0 ^{h}	14.0 ^{cd}
6	T_{G2}	18.6 ^{f}	14.0 ^{cd}
7	T_{G3}	19.7 ^{c}	15.0 ^{bc}
8	T_{G4}	20.6 ^{a}	16.8 ^{a}
9	T_{W}	20.0 ^{b}	15.8 ^{ab}
$LSD_{0.05}$		*0.03*	*1.08*

The same letters indicated not significantly different at 0.05 level
Source: Own calculation.

These results may be due to that, increasing number of pulses gives a chance for straw to absorb the water more efficiently. Extraction the fibers under greenhouse increased fiber yield rate comparing with extraction in open field at different number of pulses from one to four as fallow: Sakha 3 (1.1, 2.2, 4.8 and 5.6) % and Giza 12 (4.5, 1.4, 6.4 and 12.0) %. Water/Submerged (T_W) retting produced fiber yield rate more than one pulse (continuous) as fallow: for Sakha 3 ($T_W > T_{F1}$ = 12.4 % and $T_W > T_{G1}$ = 11.1 %) and for Giza 12 ($T_W > T_{F1}$ = 17.9 % and $T_W > T_{G1}$ = 12.9 %). T_W increased fiber yield rate more than T_{F4} for two varieties Sakha 3 and Giza 12 by 2.6 and 5.3 % respectively, while T_W decreased fiber yield rate less than T_{G4} for two varieties by 2.9 and 6.0 % respectively.

Fiber length

The fiber length (cm) in relation to fiber extraction method and environment for two varieties Sakha 3 and Giza 12 are listed in Table 6. Analysis of variance showed significant difference in fiber length between different treatments. Comparing means showed that the highest effect in fiber length for variety Sakha 3 obtained by T_W and T_{G4} treatments with value of 90.0 cm and the highest effect in fiber length for variety Giza 12 obtained by T_{G4} treatment with value of 87.0 cm. The lowest effect in fiber length with value of 65.0 cm obtained by T_{F1} for variety Sakha 3 and obtained by T_{F1} and T_{F2} for variety Giza 12.

Table 6. Fiber length (cm) and compare means for two flax varieties under different fiber extraction methods and environments

Treatment		Fiber length (cm)	
		Sakha 3	Giza 12
1	T_{F1}	65.0 ^{e}	65.0 ^{d}
2	T_{F2}	80.0 ^{c}	65.0 ^{d}
3	T_{F3}	80.0 ^{c}	70.0 ^{c}
4	T_{F4}	85.0 ^{b}	80.0 ^{b}
5	T_{G1}	75.0 ^{d}	70.0 ^{c}
6	T_{G2}	75.0 ^{d}	80.0 ^{b}
7	T_{G3}	80.0 ^{c}	80.0 ^{b}
8	T_{G4}	90.0 ^{a}	87.0 ^{a}
9	T_{W}	90.0 ^{a}	80.0 ^{b}
$LSD_{0.05}$		*4.9*	*4.5*

The same letters indicated not significantly different at 0.05 level
Source: Own calculation.

The obtained results referred to that for two varieties fiber length were affected by fiber extraction method and environment. Under sprinkler retting, increasing pulses from one to four enhanced fiber length for different treatments. Fiber extraction under greenhouse improved fiber length comparing with the extraction in open field where the greenhouse provides a permanently saturated environment. The results explained that T_{F4} not enhanced fiber length comparing with T_W where for Sakha 3 the fiber length decreased by 5.6% and for Giza 12 fiber length not changed; these results are consistent with that obtained by previous research work [6]. T_{G4} produced the same fiber length obtained by T_W for Sakha 3 while achieved 8.8% increase for Giza 12.

Water productivity

Water productivity (kg/m^3) in relation to fiber extraction method and environment for two varieties Sakha 3 and Giza 12 are listed in Table 7. Analysis of variance showed high significant difference in water productivity between different treatments. Comparing means showed that T_{G4} treatment had the highest effect in water productivity with values of 27.5 and 21.2 kg/m^3 for two varieties Sakha 3 and Giza 12 respectively which increased by about 37.5 and 61.8% more than T_W treatment for two varieties; while T_{F1} treatment had the lowest effect with values of 18.2 and 11.9 kg/m^3 for two varieties respectively which decreased by about 9.0 and 9.2% less than T_W treatment for two varieties respectively. Application of pulse sprinkler technique improved water productivity comparing with traditional method; this is may be due to its effect on total applied water and fiber yield rate as mentioned above.

Table 7. Water productivity (kg/m^3) and compare means for two flax varieties under different fiber extraction methods and environments

Treatment		Water productivity (kg/m^3)	
		Sakha 3	Giza 12
1	T_{F1}	18.2 ^{h}	11.9 ^{f}
2	T_{F2}	19.3 ^{g}	13.7 ^{de}
3	T_{F3}	21.6 ^{d}	15.0 ^{c}
4	T_{F4}	23.6 ^{c}	17.4 ^{b}
5	T_{G1}	20.0 ^{f}	14.1 ^{d}
6	T_{G2}	21.3 ^{e}	15.0 ^{c}
7	T_{G3}	24.3 ^{b}	17.6 ^{b}
8	T_{G4}	27.5 ^{a}	21.2 ^{a}
9	T_W	20.0 ^{f}	13.1 ^{e}
LSD $_{0.05}$		*0.16*	*0.65*

The same letters indicated not significantly different at 0.05 level
Source: Own calculation.

Increasing number of pulses from one to four enhances water productivity as fallow: Sakha 3 ($T_{F2} > T_{F1}$ = 6.0%, $T_{F3} > T_{F2}$ = 11.9%, $T_{F4} > T_{F3}$ = 9.3%, $T_{G2} > T_{G1}$ = 6.5%, $T_{G3} > T_{G2}$ = 14.1% and $T_{G4} > T_{G3}$ = 13.2%) and Giza 12 ($T_{F2} > T_{F1}$ = 15.1%, $T_{F3} > T_{F2}$ = 9.5%, $T_{F4} > T_{F3}$ = 16.0%, $T_{G2} > T_{G1}$ = 6.4%, $T_{G3} > T_{G2}$ = 17.3% and $T_{G4} > T_{G3}$ = 20.0%). Extracting the fiber under greenhouse improved water productivity comparing with extracting in open field as fallow: Sakha 3 ($T_{G1} > T_{F1}$ = 9.9%, $T_{G2} > T_{F2}$ = 10.4%, $T_{G3} > T_{F3}$ = 12.5% and $T_{G4} > T_{F4}$ = 16.5%) and Giza 12 ($T_{G1} > T_{F1}$ = 18.5%, $T_{G2} > T_{F2}$ = 9.5%, $T_{G3} > T_{F3}$ = 17.3% and $T_{G4} > T_{F4}$ = 21.8%).

CONCLUSIONS

Flax fiber extraction using pulse sprinkler technique can be considering an alternative method to overcome the problems of traditional method. Application pulse sprinkler under greenhouse saved applied water and enhanced fiber yield rate and water productivity comparing with pulse sprinkler in open field. The best result was obtained by T_{G4} treatment. It achieved fiber yield rate 3.0 and 6.3% and water productivity 37.5 and 61.8% more than T_W treatment for two varieties Sakha 3 and Giza 12 respectively. Application sprinkler method not occupies area and needless labor like retting basin in traditional method.

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PANGIUM SP. LEAF EXTRACT AS BIOPESTICIDE ON *BRASSICA OLERACEA* PLANT IN NORTH SULAWESI PROVINCE, INDONESIA

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Abstract

Pangium sp. has the potential to be developed as a biopesticide because it has the ability to inhibit the activity of several types of insect pests. In this study, pangium leaf extract and pesticide were applied to Brassica oleraceae cabbage farms; to determine the type and population of pests and their natural enemies. Each carried out on an area of 500m^2, with 1,250 cabbage plants. Observation and sampling of insects and natural enemies at the larval stage, were carried out seven times every seven days starting on 14 DAP (days after planting); diagonally, where there are five sampling spots, by sweeping using insect nets five times; then collected and identified. Results indicated on the treatment area of pangium leaf extract found seven types of pests: Plutella xylostella, Crocidolomia pavonana, Aphis sp., Liriomyza brassicae, Spodoptera sp., Chrysodeixis calcites, Grylotalpa sp., and Parmarion sp.; dominated by P. xylostella and C. pavonana. The natural enemies found were six types of predators: Coenagrionidae, Asilidae, Mantidae, Sphecidae, Libellula sp., Menoxhilus sexmaculata and one parasitoid Diadegma semiclausum. In the pesticide treatment, four types of pests: P. xylostella, C. pavonana, Aphis sp; L. brassicae; and four types of natural enemies/predators: Coenagrionidae, Asilidae, Mantidae, Sphecidae and one parasitoid D. semiclausum. The average population in the pangium leaf extract treatment area, pests 8.91 individuals, natural enemies/predators 2.35 individuals and parasitoids 6.13 individuals. In the pesticide treatment area: pests 3.05 individuals, natural enemies/predators 1.2 individuals and parasitoids 0.51 individuals.

Key words*: *leaf extraction, cabbage, natural enemies, pests, parasitoid

INTRODUCTION

Cabbage belongs to the order *Brassicales*, family *Brassicaceae*, genus *Brassica*. *Brassica oleracea* is a species of plants such as cabbage, broccoli, cauliflower, from the wild cabbage plant before cultivation, which is native to Western Europe. Now *B. oleracea* is selected by farmers with various shapes/appearances and traded under several names. The part of the plant that is used is either a swollen stem base, separate leaves, shoots with tightly growing leaves or flowers that grow close together, usually not easy to grow in the tropics. *B. oleracea* is relatively thick green in color with a slight white tinge due to the surface covered with fine hairs. In some varieties the leaves are arranged in a dense rosette and sit on the stem. In the lowlands, the size of the crop is reduced and the plant is very susceptible to Plutella leaf-eating caterpillars [22, 5]. Because the selling price of cabbage is determined by its appearance, farmers often spray cabbage plants with insecticides in excessive quantities so that the cabbage does not have holes in its leaves due to being eaten by caterpillars.

The green revolution that occurred in the past few decades was marked by the use of superior varieties, chemical fertilizers and pesticides to produce phenomenal growth in agricultural productivity, resulting in high production yields and impressive profits, but on the other hand, undesirable consequences such as pollution emerged environment due to the uncontrolled use of chemicals, resulting in damage to the agricultural environment. The pesticide residues found in soil, air, and water as well as on agricultural products produced; consequently, they can endanger human health and the environment. This is in accordance with the opinion of Kumar (2012)[12], that the indiscriminate use of chemical fertilizers and pesticides in the agricultural industry causes contamination of water and food sources and the development of insect populations that are resistant to insecticides.

The increasing concern about the adverse impact on the environment associated with the use of synthetic chemical products has prompted efforts to search for technologies and natural products based on biological processes to control pests. In developing a control strategy against plant pests, it is necessary to pay attention to the risks that occur, both to humans and the environment [26]. Therefore, a control strategy that is safe for farmers is needed in order to protect their crops, but not harmful to humans and the environment. According to *Lindsey et al.* (2020) [13], there are several methods that have been applied in pest management so far, both traditional methods, chemical methods and biological methods.

The use of biopesticides can be applied as an alternative to plant pest control because it is proven to be effective for pest control and produces sustainable agricultural products [18]. Biopesticides are organic compounds and antagonistic microbes that inhibit or kill plant pests and diseases [23]. Several factors indicate that bio-pesticides are an excellent alternative to synthetic pesticides, namely they are very effective, have specific targets and have less environmental risks [6]. Biopesticides are a good alternative in an effort to increase crop production, the use of which will increase in the coming years [17], which further states that this biological control can reduce greenhouse gas emissions compared to chemical pesticides [7].

Plants are widely known to produce various secondary metabolites/compounds such as flavonoids, terpenoids, alkaloids, saponins and others that are useful as a means of self-defense [2]. The search for plants that can produce biopesticides, such as antifeedant to control insect pests, is of great interest to researchers around the world. This is because in plant protection, antifeedant compounds do not kill, repel or trap insect pests, but only inhibit the appetite of these insects, so that food crops or commodity crops can be protected. An antifeedant compound is a compound that, if tested on insects, will temporarily or permanently stop appetite. Insect pest control using compounds that inhibit feeding activity provides several advantages such as not causing resistance, high selectivity, easy to degrade, and relatively non-toxic to humans [14].

One of the plants that has the potential as a bio-pesticide is *Pangium* sp., where the leaves of this pangium plant contain at least 11 compounds and 8 compounds have been successfully identified, namely: pinene; trimethylbenzene; triflorotetradecylacetic acid; nonadekene; 13-hexyloxacyclotridec-10-en-2-on; phytol; 3 eicosene; and diisooctylbenzendicarboxylic acid [16}. While the Pangium fruit, in addition to containing cyanide acid, also contains vitamin C, iron ions, beta-carotene, hidnocarpat acid, khaulmograt acid, glorat acid, and tannins [21]. Pangium leaf extract was able to inhibit the feeding activity of *Plutella xylostella* larvae [20, 16]. The lethal concentration 50 (LC 50) of pangium leaf extract against *Crocidolomia pavonana* larvae at a concentration of 1,360 ppm [1].

This study used pangium leaf extract which was sprayed on cabbage farms. The aim is to determine the types and populations of pests and their natural enemies, which are applied with pangium leaf extract and then compare them with the types and populations of pests and their natural enemies found in cabbage plants that are sprayed with pesticides. This study is expected to provide data and information on the use of pangium leaf extract in cabbage cultivation activities, especially in plant pest control.

MATERIALS AND METHODS

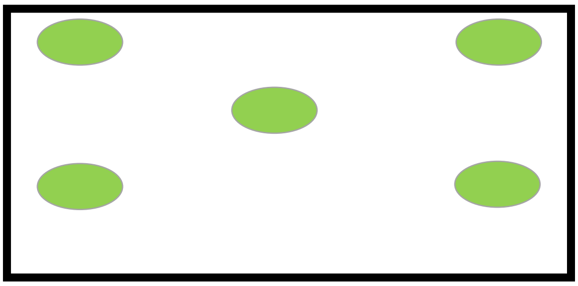
The research was conducted from April to July 2021, starting with the preparation of pangium leaf extract as biopesticides, then continued with sampling and insect observations. The method, does not use a special design because it is carried out based on primary data, namely direct observation data at the research location, on an area of $500m^2$, a length of 25 meters and width of 20 meters; there are 10 beds in the observation area; with observation were carried out seven times, with intervals every seven days , starting on days 14, 21, 28, 35, 42, 49, and 56 DAP (days after planting); diagonally, where there are five sampling spots, and the number of plants observed is 1,250 plants/0.05 ha (equivalent to 25,000 plants/ha).In this study, observations were made on the types and populations of pests and natural enemies on cabbage farms, which were sprayed with pangium leaf extract as biopesticides, compared to those sprayed with pesticides. Each pest and natural enemies sampling spot at the larval stage, there were 25 cabbage plants, by sweeping using insect nets five times; then collected and identified.

Preparation of pangium leaf extract

The collected pangium leaves are washed with running water and then dried. As much as 2 kg of pangium leaves, thinly sliced and pounded until smooth and then blended. Next, 60 grams of detergent was added as an adhesive and mixed with 20 liters of water and shaken until homogeneous, and allowed to stand for 24 hours. After 24 hours, the solution was filtered using gauze, so that the extract was obtained and the extraction solution was ready for use [25, 9]. For application in the field, for an area of 500 m^2, two liters of extract solution can be used; and the use of extracts was carried out once a week for one growing season (between 65 – 75 days after planting).

Sampling and pest observation

Sampling on plants was carried out directly by taking the insect larvae found. Sampling was carried out using the diagonal slice method, so that there were five sampling spots on agricultural land, and each spot was determined to be taken as many as 25 plants as shown in Figure 1.



Notes:

= Sampling location

= Sampling sub-location

Fig.1. Diagonally sampling layout
Source: Own design.

Observation of pest population density is done by collecting and counting the number of pests found, were made 7 times when the plants were 14, 21, 28, 35, 42, 49 and 56 DAP (day after planting). The following formula was used to calculate the population density:

$$P = \frac{n}{N}$$

Notes: P = average population density
n = number of pests found
N = number of observations

Natural enemy sampling and observation

Sampling of natural enemies using insect nets was carried out by sweeping with five double swings on the surface of cabbage plantations. Observations of parasitoids were carried out by collecting pests at the larval stage and then rearing and observing the appearance of parasitoids. The larvae of these pests are usually hosts for parasitoids. The parasitoid imago that came out of the pupa was collected and then identified. The population density of natural enemies, both predators and parasitoids, was calculated using the same formula as the calculation of the pest population density. The collected samples were then identified according to Kalshoven (1981) [11] and [3].

RESULTS AND DISCUSSIONS

Pest type and population density

From the observations, it was found that there were seven types of pests, namely *Plutella* *xylostella*, *Crocidolomia pavonana*, *Spodoptera* sp., *Chrysodeixis chalcites*, *Liriomyza brassicae, Aphis* sp., *Parmarion* sp. The most dominant pests found were *P. xylostella* and *C. pavonana*.

P. xylostella had an average population density of 19.31 individuals and was mostly found at plant ages of 21 DAP to 35 DAP and decreased in population at 42 DAP. Young larvae of *P. xylostella* feed on cabbage leaves by leaving the epidermal tissue to form transparent spots that are visible as white patches. The attack of the adult larvae causes the cabbage leaves to have holes and if the population is high enough, the attack will be more severe so that only the bones and veins are left behind and the plant does not form a crop or a crop can be formed but in abnormal conditions. Adult larvae when disturbed squirm and quickly fall through the threads that are released. With this thread the larvae can climb again to the leaf surface. Rainfall conditions in the early weeks were relatively low, presumably causing the relatively high population of *P. xylostella*. Rainfall can affect the development of insect populations in nature, because high rainfall will cause damage or death of egg and larval/nymph stages, especially small ones. In humid conditions and high rainfall intensity insect development will be suppressed, on the contrary in relatively long summer conditions will support its development so that the population in nature will be high [11, 4]. The average pest population density is given in Table 1.

Table 1. Average Pest Population Density in Treatment of Pangium Leaf Extract and Chemical Pesticides

Pest type	**Observation time (days after planting = DAP)**							**Mean**
	14	**21**	**28**	**35**	**42**	**49**	**56**	
	(individual)							
C. pavonana	0	0	2.3	14.6	37.7	40.1	22.7	16.77
P. xylostella	5.1	31.7	33.6	37.9	15.7	5.9	5.3	19.31
Spodoptera sp.	0	2.2	3.2	0	0	1.8	0.6	1.11
L. brassicae	3.3	2.5	4.4	3.5	2.8	8.5	3.2	4.03
C. chalcites	0	0.4	1.5	0	0	1.8	0.9	0.66
Aphis sp.	0	0.7	3.1	2.7	4.3	5.5	5.3	3.09
Pharmarion sp.	0	0	0	0	3.7	5.5	4.3	1.93

Source: Own calculation on the basis of data.

Another dominant pest found was *C. Pavonana*. This pest was mostly found at the age of plants above 49 DAP where the average population density was 16.77 individuals. Baideng *et al.* (2020) [1] reported that 3% pangium leaf extract could cause larval mortality of 76.67% at 120 HAA (hours after application). Meanwhile, Manoppo *et al.*, (2019) [15] reported 86.3% mortality of *C. pavonana* using 50 ppm Pangium leaf extract. *C. pavonana* will be seen in abundance, when the plant begins to form a crop. These larvae are clustered on the leaf surface and as the plant grows larger, the larvae are spread all over the plant, especially on the young leaves. Other pests such as *Aphis* sp., *Spodoptera* sp., *L. brassicae*, *C. chalcites* and *Pharmarion* sp., the average population density is only slightly less than five individuals. On land treated with pangium leaf extract, the average pest population was 8.91 individuals, while on land treated with pesticides, the number was 3.05 individuals (Table 2).

This amount is still below the threshold, because it does not affect crop damage that can harm farmers.

In cabbage with pesticide treatment, only 4 types of pests were found, namely *C. pavonana*, *P. xylostella*, *L. brassicae* and *Aphis* sp. The use of high-intensity pesticides is thought to cause inhibition of the development of other pests. However, the excessive use of pesticides, apart from causing environmental pollution, can also lead to pest resistance, the emergence of secondary pests and pest resurgence [19, 12].

Table 2. Average Pest Population Density in Treatment of Pangium Leaf Extract and Chemical Pesticides

Type of pest	Treatment	
	Pangium leaf extract	Pesticide
	(individual)	
C. pavonana	16.77	7.93
P. xylostella	19.31	10.77
Spodoptera sp.	1.11	0
L. brassicae	4.03	1.33
C. chalcites	0.66	0
Aphis sp.	3.09	1.37
Pharmarion sp.	1.93	0
Mean	**8.91**	**3.05**

Source: Own calculation on the basis of data.

Natural enemy type and population density

The types of predators found were 6 species, namely *Coenagrionidae*, *Sphecidae*, *Labilulla*, *Asilidae*, *Menochilus sexmaculatus*, and *Mantidae*. While in pesticide treatment, only 4 types of predators were found, namely *Coenagrionidae*, *Sphecidae*, *Labilulla* and *Asilidae*, because excessive use of pesticides can cause the death of natural enemies [19]. The presence of natural enemies is important to maintain the biological balance in the agricultural ecosystem because it can suppress the development of pests [24]. Minimizing the use of chemical insecticides is a form of conservation of natural enemies in nature [8]. Conservation is one of the techniques in biological control that functions to preserve natural enemy species in nature [10].

The predator population found means was 2.35 individuals, while on land that was sprayed with pesticides there were 1.2 individuals (Table 3).

Predatory movement activity is thought to be the cause of the reduced number of individuals that can be netted in the sampling process, but the varied types of predators found can be assumed that a predation process occurs which can cause a decrease in certain pest populations. To sustain life and generation, predators will actively seek and find their hosts [10].

Table 3. Average Predator Population Density in Treatment of Pangium Leaf Extract and Chemical Pesticides

Type of pest	Treatment	
	Pangium leaf extract	Pesticide
	(individual)	
Coenagrionidae	5.3	2.7
Libelulla sp.	1.5	1.1
Sphecidae	3.3	2.4
Asilidae	1.3	1
Menochilus sexmaculatus	1.8	0
Mantidae	0.9	0
Mean	**2.35**	**1.2**

Source: Own calculation on the basis of data.

The parasitoid found was *Diadegma semiclausum* and found in its host insect, *P. xyostela*. The average percentage of parasitization of *D. semiclausum* in the Pangium leaf extract treatment was 6.13%, while in the pesticide treatment it was 0.51% (Table 4). The small percentage of parasitization indicates that the presence of natural enemies of *D. semiclausum* on agricultural land is not yet well established. This is thought to be the cause of the high population of *P. xylostella*.

Table 4. Average Percentage of Parasitization of *D. semiclausum* to *P. xylostella* in Cabbage Plant

Treatment	Sampling (days after planting = DAP)							Mean
	14	21	28	35	42	49	56	
	(individual)							
Pangium leaf extract	0	3.3	7.5	9.7	8.1	8.8	5.5	6.13
Pesticide	0	0	0.7	1.4	0.5	0.3	0.7	0.51

Source: Own calculation on the basis of data.

D. semicalisum is a solitary parasitoid that is endo-parasitic because in one host pupa, only one individual parasitoid is found. These parasitoids belong to the Order *Hymenoptera*, Family *Ichneumonidae,* and Genus *Diadegma* [3, 8]. Parasitoid *D. semiclausum* was found in the host *P. xylostella* both in the treatment of pangium leaf extract and pesticides.

CONCLUSIONS

There were seven types of pests on cabbage plantations that were applied with pangium leaf extract, namely *P. xylostella*, *C. pavonana*, *Spodoptera* sp., *C. chalcites*, *L. brassicae*, *Aphis* sp., *Parmarion* sp, with an average pest population of relatively small, namely 8.91, while in pesticide treatment land only four types of pests were found, namely *C. pavonana*, *P. xylostella*, *L. brassicae* and *Aphis* sp., and the pest population was 3.05 individuals on average. The dominant pests whose populations were found in observations were *P. xylostella* and *C. pavonana*. The natural enemies found in the pangium leaf extract treatment area were six types of predators (Coenagrionidae, Sphecidae, Labilulla, Asilidae, *M. sexmaculatus*, and Mantidae) and one parasitoid (*D. semiclausum*). In the pesticide treatment area, there were fewer predators, namely four types of predators (Coenagrionidae, Sphecidae, Labilulla and Asilidae) and one parasitoid (*D. semiclausum*). The population of natural enemies in the pangium leaf extract treatment area averaged 2.35 individuals (predators) and 6.13 individuals (parasitoids). Meanwhile, in the pesticide treatment area, the population of predators is 1.2 individuals and parasitoids are 0.51 individuals. Based on the data obtained, it shows that the use of pangium leaf extract as a bio-pesticide is better for use on cabbage plantations. This is based on the type and population of pests and natural enemies found, although they are almost the same as those found in pesticide treatment areas, but in greater numbers.

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STUDY ON VEGETATIVE PROPAGATION OF SOME SAINTPAULIA GENOTYPES

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Abstract

The present study evaluated the vegetative propagation of Saintpaulia (African violets). Five genotypes of Saintpaulia were used: Saintpaulia ionantha Shades of Autumn (G1), Saintpaulia ionantha Zoja (G2), Saintpaulia ionantha Delft (G3), Saintpaulia ionantha Milky Way Trail (G4) and Saintpaulia ionantha Tongwenis (G5). Three growth substrates consisting of sand (San, Gs1), sand and peat (San/Pea, 1:1 mixture, Gs2) and perlite and peat (Per/Pea, 1:1, Gs3 mixture) were used. From the combination of genotypes with growth substrates, 15 experimental variants were obtained. The experiment was organized in a protected space, with 15 leaf cuttings on each variant, in three repetitions. The number of rooted shoots (Sn) and the length of the roots (Rl) were evaluated. Compared to the experience average, there were positive differences in statistical safety conditions for variants V2, V7, V8 and V14 (for LSD0.1%). Negative differences in statistical safety conditions were recorded in variants V3, V4, V6 and V15 (for LSD0.1%), and in variants V10 and V12 (for LSD1%). According to the PCA, PC1 explained 85.684% of the variance, and PC2 explained 14.316% of the variance. Cluster analysis led to the grouping of variants based on Euclidean distances, in relation to the values generated for Sn and Rl, in statistical safety conditions (Coph.corr = 0.784). The result was two distinct clusters, with several subclusters each. The analysis of SDI values found the highest level of similarity between variants G1-Gs1 and G4-Gs1 (SDI = 0.3607), followed by variants G2-Gs2 and G4-Gs1 (SDI = 0.4000), respectively by variants GG4-Gs2 with G5-Gs2 (SDI = 0.5900).

Key words: *growth substrate, leaf cuttings, PCA, Saintpaulia, vegetative propagation*

INTRODUCTION

Ornamental plants with flowers or leaves in pots are of great decorative interest for indoor and outdoor spaces (for a certain period of the year) both in public spaces and in private and family spaces [29].
Some studies have been made on costs and aspects of a technical, economic, social, market nature, as well as the consumer profile, in relation to different categories of potted ornamental plants [24], [41], [12], [4], [23], [33].
Numerous species (genotypes, varieties) fall into this category of ornamental plants (in pots), and their cultivation requires specific substrates or growth media [5], [16], [20], [21], [6], [13], [38]. Among the species of decorative plants with potted flowers is *Saintpaulia ionantha* H. Wendl [42].
Growing substrates can be represented by a single component (peat, sand, vermiculite etc.), or mixtures of two or more components, in order to ensure optimal conditions in relation to the specifics of ornamental plants [39].
The multiplication of ornamental plants can be done both generative and vegetative methods, with advantages and disadvantages in relation to the plant species [2], [11], [35], [37], [18].
Vegetative propagation is easy for many species of ornamental plants [14], [28], [34], [36], and can be done even in private-family spaces, respecting some minimum requirements.
The propagation conditions of ornamental plants, as well as those following the production of biological material, are very important for ensuring and maintaining the quality of plants for market (commercial aspect), as well as later during use (ornamental aspect) [15].
The conditions of multiplication, growth, as well as post-production conditions (eg storage, transport), can have major effects on

the commercial and ornamental quality of plants.

The flower market is very dynamic, with a differentiated weight in relation to the category of flowers (cut flowers, potted flowers, and biological material), season or off-season, category of beneficiaries, destination of use, etc., and as a result, some studies addressed the dynamic role of this component in the market [7].

The interest for the propagation methods of the ornamental plants is very high for technical, economic, social reasons, and different studies have approached this aspect [26], [27].

Saintpaulia has been studied on the basis of different indices and morphological and physiological parameters, in relation to *In vitro* multiplication, bioactive substances and ex vitro conditions [19], [8], [43].

Viable commercial production will require cultivation techniques that produce flowering plants throughout the year [44].

Sustainable flower production is increasingly being promoted through environmentally friendly practices [3]. Some natural polysaccharides and their derivatives are studied and used in horticulture to stimulate plant growth [40].

Different species of potted ornamental plants have been studied in relation to certain pathogenic species in indoor spaces or gardens [17]. Non-destructive methods of plants foliar study was also promoted, based on imaging analysis [9], [10].

The present study addressed the vegetative propagation of five Saintpaulia genotypes in relation to different growing substrates, in order to obtain decorative plants in pots.

MATERIALS AND METHODS

Vegetative propagation has been studied in order to obtain decorative flowers. The biological material was represented by five genotypes in Saintpaulia: *Saintpaulia ionantha* Shades of Autumn (G1); *Saintpaulia ionantha* Zoja (G2); *Saintpaulia ionantha* Delft (G3); *Saintpaulia ionantha* Milky way Trail (G4); *Saintpaulia ionantha* Tongwenis (G5), figure 1. Leaf cuttings were taken from each genotype.

Saintpaulia ionantha Shades of Autumn (G1)	*Saintpaulia ionantha* Zoja (G2)	*Saintpaulia ionantha* Delft (G3)	*Saintpaulia ionantha* Milky way Trail (G4)	*Saintpaulia ionantha* Tongwenis (G5)

Fig. 1. Saintpaulia genotypes studied for vegetative propagation by leaf shoots
Source: Original images from the experiment.

Three growth substrates (Gs) consisting of sand (San, Gs1), sand and peat (San / Pea, Gs2) and perlite and peat (Per / Pea, Gs3) were prepared. The mixtures of sand and peat (Gs2), respectively perlite and peat (Gs3) were made in a 1:1 ratio between the components. The experiment was organized in a protected space, with 15 leaf cuttings on each variant, in three repetitions.

To stimulate rooting, the cuttings were treated with Radistim.

The number of rooted shoots (Sn) in each variant and the length of the roots (Rl) were evaluated.

Experimental data were analyzed by Variance Analysis, ANOVA test, PCA, Cluster Analysis. To evaluate the differences between the variants, the values LSD5%, LSD1% and LAS0.1% (Limits of Significance of Differences) were calculated. For the safety of the data, the F test, the values R^2, p, the cophenetic coefficient were taken into account.

PAST software [22] and EXCEL calculation modules were used to process data and make distribution graphs.

RESULTS AND DISCUSSIONS

Leaf cuttings from the five Saintpaulia genotypes were rooted for vegetative propagation in three types of growing substrates, sand (San, G1), sand and peat (San/Pea, G2) and perlite and peat (Per/Pea, G3). The number of rooted cuttings in each genotype and growing substrate was evaluated.

For the evaluation of the differences between the variants and their significance, the Variance Analysiswas used, and the results are presented in Table 1.

Compared to the experience average, there were positive differences in statistical safety conditions for variants V2, V7, V8 and V14 (for LSD0.1%). Negative differences in statistical safety conditions were recorded in variants V3, V4, V6 and V15 (for LSD0.1%), and in variants V10 and V12 (for LSD1%). Other differences were also registered but without statistical assurance.

Table 1. Number of shoots rooted to Saintpaulia genotypes studied according to the growing substrate

Genotype and Growth substrate	Trial variant	Mean values	Differences and Significance
G1-Gs1	V1	8.50	-0.46
G1-Gs2	V2	10.78	1.82***
G1-Gs3	V3	7.11	-1.85ººº
G2-Gs1	V4	7.50	-1.46ººº
G2-Gs2	V5	9.30	0.34
G2-Gs3	V6	5.91	-3.05ººº
G3-Gs1	V7	11.21	2.25***
G3-Gs2	V8	12.41	3.45***
G3-Gs3	V9	8.83	-0.13
G4-Gs1	V10	8.24	-0.73ºº
G4-Gs2	V11	9.68	0.72*
G4-Gs3	V12	8.05	-0.92ºº
G5-Gs1	V13	9.17	0.20
G5-Gs2	V14	10.03	1.07***
G5-Gs3	V15	7.445	-1.52ººº
Control (experiment average)		8.96	-
Limits of Significance of Differences (LSD)		LSD5%=0.538; LSD1%=0.724; LSD0.1%=0.963	

Source: original values calculated based on the experimental data obtained.

The ANOVA test confirmed the presence of the variance and the statistical safety of the experimental data set regarding the shoot number obtained for the Saintpaulia genotypes studied in relation to the growth substrate (Table 2).

Table 2. ANOVA test for experimental data on the studied Saintpaulia genotypes

Source of Variation	SS	df	MS	F	P-value	F crit
Rows	66.1664	2	33.0832	106.943	7.76E-14	8.93051
Columns	50.5579	14	3.61128	11.6737	3.3E-08	3.93187
Error	8.66187	28	0.30935			
Total	125.386	44				

Source: original data obtained by calculations.

Statistical analysis of the frequency of values for shoots number showed a normal distribution (Figure 2).

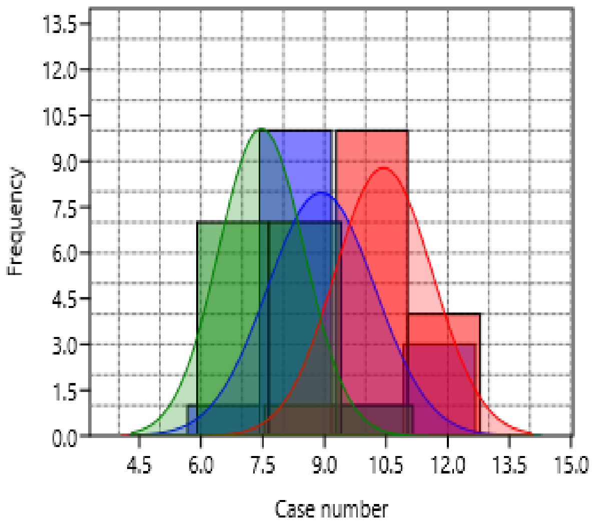

Fig. 2. Distribution histogram of shoots values in Saintpaulia genotype studied (San – blue colour; San/Pea – red colour; Per/Pea – gren colour)

Source: original graph, generated based on experimental values.

In the conditions of the three growing substrates and of the obtained cuttings, for the length of the cuttings roots were registered values between 0.5 cm (G1-Gs3) and 4.65 cm (G3-Gs2, G5-Gs2), Figure 3.

According to PCA, the distribution diagram of the experimental variants in relation to shoot number (Sn) and root lenght (Rl) was obtained for the shoots of the 5 Saintpaulia genotypes studied, Figure 4.

PC1 explained 85.684% of variance, and PC2 explained 14.316% of variance.

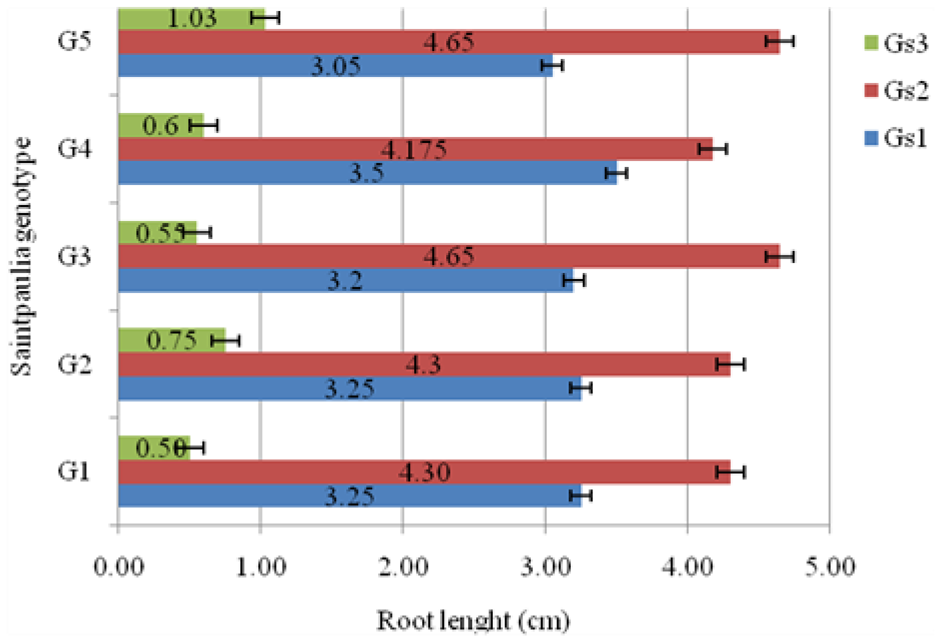

Fig. 3. Graphic distribution of root length values in relation to Saintpaulia genotype and growth substrate
Source: original graph, generated based on experimental values.

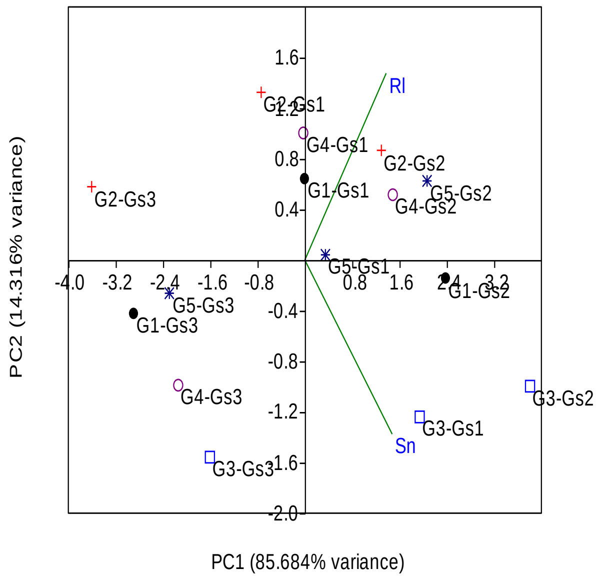

Fig. 4. PCA diagram regarding the distribution of experimental variants for vegetative propagation in Saintpaulia
Source: original diagram generated based on experimental data.

From the analysis of the distribution of variants, it was found the association of some variants (genotype x growth substrate) with Sn and Rl, which confirms the dependence of these genotypes on the growth substrate (G1-Gs2, G2-Gs2, G3-Gs1, G3-Gs2, G4 -Gs2, G5-Gs1, and G5-Gs2). The close position was at variants G1-Gs1, G2-Gs1, and G4-Gs1.

On the other hand, an independent position of other variants was found in relation to Sn and R1, which shows a certain independence of these genotypes from the growth substrate (G1-Gs3, G2-Gs3, G3-Gs3, G4-Gs3 and G5-Gs3). This shows that all variants with the Gs3 substrate (Per/Pea) generated low results on Sn and Rl in the multiplication of the Saintpaulia genotypes studied.

Cluster analysis led to the grouping of variants based on Euclidean distances, in relation to the values generated for Sn and Rl, in statistical safety conditions (Coph.corr = 0.784), Figure 5.

From the analysis of the grouping of variants based on similarity in the generation of results, it was found the formation of two distinct clusters. A C1 cluster contains variants on the Gs3 growth substrate (Per/ Pea), which provided the lowest multiplication rate under the experimental conditions for all five Saintpaulia genotypes studied.

Cluster C2 comprises the other variants grouped in three subclusters. The V8 variant (G3-Gs2) with the best results regarding the vegetative propagation in the study conditions was placed on an independent position.

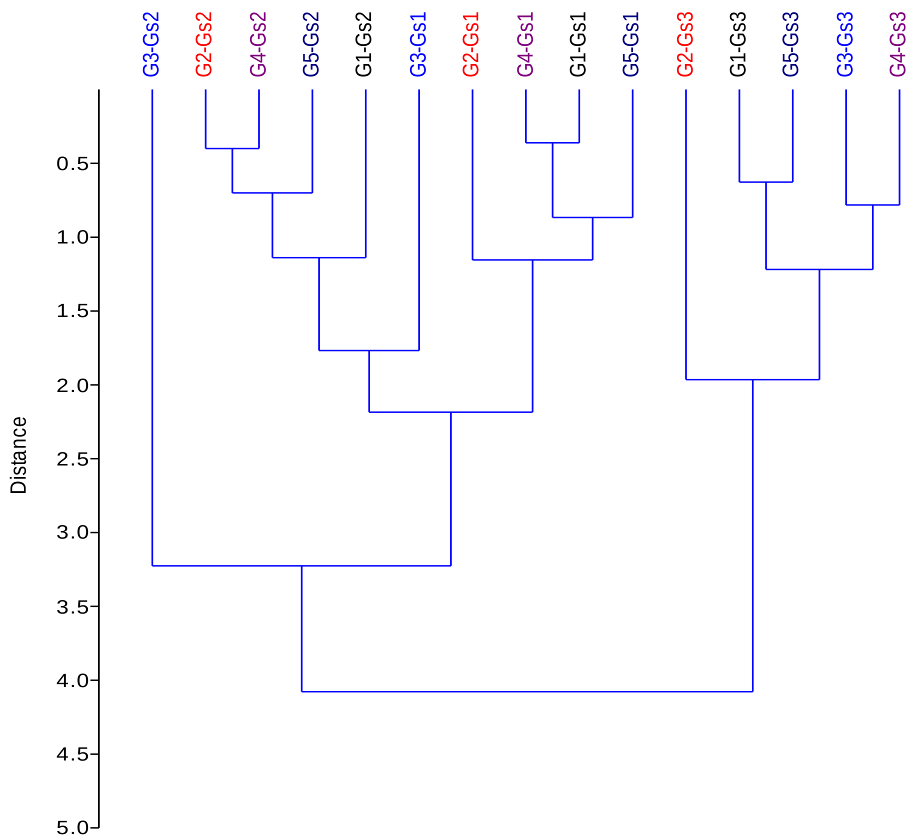

Fig. 5. Dendrogram of variants regarding vegetative propagation in Saintpaulia, in relation to genotype and growth substrate
Source: original diagram generated based on experimental data.

Within a C2-1 subcluster, four variants were grouped, associated with the growth substrate Gs1, respectively variants V1 (G1-Gs1), V4 (G2-Gs1), V10 (G4-Gs1) and V13 (G5-Gs1). The variants V2 (G1-Gs2), V5 (G2-Gs2), V7 (G3-Gs1), V11 (G4-Gs2) and V14 (G5-Gs2) were grouped in subcluster C2-2.

The analysis of SDI values found the highest level of similarity between variants G1-Gs1 and G4-Gs1 (SDI = 0.3607), followed by variants G2-Gs2 and G4-Gs1 (SDI = 0.4000), respectively by variants GG4-Gs2 with G5-Gs2 (SDI = 0.5900), Table 3.

In the present study, the product Radistim was used as a biostimulator for rooting cuttings in the Saintpaulia genotypes studied. Various bioactive substances are of interest for ornamental horticultural species in relation to propagation methods, quality of biological material, stimulation of growth and development, flowering, tolerance to stressors [29], [1].

Biostimulating substances are useful for vegetative propagation of plants in order to stimulate rooting and obtain quality biological material. Mladenović et al. (2016) [30] eported favorable results on vegetative propagation in Saintpaulia by treating leaf cuttings with biostimulators (Incit-1, Incit-5).

In relation to vegetative propagation, the favorable effect of biostimulating substances has been registered in different ornamental species [32], [25], [31].

From the analysis of the data obtained regarding the vegetative multiplication of the five studied Saintpaulia genotypes, of the PCA diagram and of the Euclidean distribution dendrogram, can be chosen those growth substrates that ensured a better multiplication rate, in relation to each genotype.

The G3 genotype (Saintpaulia ionantha Delft) had the best propagation rate compared to the other genotypes studied, due to the high ecological plasticity in relation to the growing substrate.

The substrate consisting of a mixture of sand and peat (Gs2) provided a better rate of multiplication by leaf cuttings in most of the Saintpaulia genotypes studied, compared to the other two substrates tested (Gs1 and Gs3).

Table 3. SDI values for the experimental variants regarding the vegetative propagation in Saintpaulia in relation to the growing substrate

	G1-Gs1	G1-Gs2	G1-Gs3	G2-Gs1	G2-Gs2	G2-Gs3	G3-Gs1	G3-Gs2	G3-Gs3	G4-Gs1	G4-Gs2	G4-Gs3	G5-Gs1	G5-Gs2	G5-Gs3
G1-Gs1		2.5102	3.0813	1.0000	1.3200	3.5997	2.7105	4.1531	2.7201	0.3607	1.4993	2.6879	0.6992	2.0739	2.4579
G1-Gs2	2.5102		5.2829	3.4440	1.4800	6.0266	1.1811	1.6672	4.2267	2.6630	1.1071	4.5981	2.0383	0.8277	4.6707
G1-Gs3	3.0813	5.2829		2.7775	4.3859	1.2258	4.9092	6.7315	1.7207	3.2058	4.4845	0.9453	3.2781	5.0743	0.6270
G2-Gs1	1.0000	3.4440	2.7775		2.0839	2.9628	3.7103	5.1057	3.0098	0.7811	2.3681	2.7065	1.6819	2.8915	2.2207
G2-Gs2	1.3200	1.4800	4.3859	2.0839		4.9086	2.2041	3.1296	3.7793	1.3280	0.4000	3.9054	1.2567	0.8096	3.7595
G2-Gs3	3.5997	6.0266	1.2258	2.9628	4.9086		5.8389	7.5802	2.9268	3.6044	5.0935	2.1453	3.9897	5.6731	1.5603
G3-Gs1	2.7105	1.1811	4.9092	3.7103	2.2041	5.8389		1.8822	3.5619	2.9851	1.8143	4.0921	2.0455	1.8695	4.3456
G3-Gs2	4.1531	1.6672	6.7315	5.1057	3.1296	7.5802	1.8822		5.4430	4.3257	2.7710	5.9508	3.6135	2.3800	6.1446
G3-Gs3	2.7201	4.2267	1.7207	3.0098	3.7793	2.9268	3.5619	5.4430		3.0084	3.7233	0.7816	2.5230	4.2720	1.4658
G4-Gs1	0.3607	2.6630	3.2058	0.7811	1.3280	3.6044	2.9851	4.3257	3.0084		1.5904	2.9062	1.0332	2.1276	2.5948
G4-Gs2	1.4993	1.1071	4.4845	2.3681	0.4000	5.0935	1.8143	2.7710	3.7233	1.5904		3.9291	1.2352	0.5900	3.8583
G4-Gs3	2.6879	4.5981	0.9453	2.7065	3.9054	2.1453	4.0921	5.9508	0.7816	2.9062	3.9291		2.6939	4.5081	0.7422
G5-Gs1	0.6992	2.0383	3.2781	1.6819	1.2567	3.9897	2.0455	3.6135	2.5230	1.0332	1.2352	2.6939		1.8165	2.6563
G5-Gs2	2.0739	0.8277	5.0743	2.8915	0.8096	5.6731	1.8695	2.3800	4.2720	2.1276	0.5900	4.5081	1.8165		4.4482
G5-Gs3	2.4579	4.6707	0.6270	2.2207	3.7595	1.5603	4.3456	6.1446	1.4658	2.5948	3.8583	0.7422	2.6563	4.4482	

Source: original values resulting from the analysis of experimental data.

CONCLUSIONS

The study on the vegetative propagation of the five Saintpaulia genotypes, on three growth substrates, highlighted the specific response of each genotype in relation to the growth substrate, in statistical safety conditions.

The Gs3 growth substrate (Per/Pea) provided the lowest propagation rate in all five Saintpaulia genotypes studied. The Gs2 growth substrate (San/Pea) facilitated the best propagation rate, by leaf cuttings, in most of the Saintpaulia genotypes studied.

The G3 genotype (*Saintpaulia ionantha* Delft) had the best propagation rate compared to the other genotypes studied, due to the high ecological plasticity in relation to the growing substrate.

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WHEN WILL THE PORK SECTOR CRISIS END IN ROMANIA?

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Abstract

This paper aimed to analyse the evolution of the pork sector in Romania, from a pig livestock trend perspective, in the context of a continuous producers struggle with the spread of African Swine Fever Virus. The research method is based on a quantitative approach, based on time data series related with pig livestock in Romania for a period of two decades. The conclusions underline a continuous negative trend of pig livestock, which has been more pronounced in the late five years, but the results of the latest international research which led to development of a vaccine, that seems to be effective against ASF virus, gives hopes that, at least for the largest pig producers, the new context will no longer force them to slaughter entire heard of pigs.

Key words: *African Swine Fever Virus, livestock, pork sector, Romania*

INTRODUCTION

The swine fever continued to be the main problem for the world pork market in 2021, but while the diseases in the European Union started to be under control, with few exceptions as Poland and Romania, the diseases started to spread in Asian countries as Bhutan and Malaysia. The authorities' efforts for the diseases control are limited of the virus present in the wild boar which transmit the virus especially to the households and small farmers which cannot provide enough security measures for their heard of pigs [8]. To be able to avoid the diseases threat, the enterprises from this sector have to invest in relation with safety measures and to develop a secure epidemiological environment. The recent researches on African Swine Fever Virus (ASFV) indicated that using live attenuated vaccines is the most promising option [13], even if many characteristics of this virus make vaccine development a difficult task for world researchers. After one hundred years of researches related with various forms of this virus [13], the scientists are close to find viable solution to protect the virus spread in the pig herds. So, this year, the Agriculture Research Services from the US Department of Agriculture's claimed to find a vaccine able to prevent and effectively protect both European and Asian bred swine against the current circulating Asian strain of the virus [17]. While the pork production declined in Romania, as we showed in recent related studies [5, 6, 7], the largest producer in Romania, the Smithfield Group which bought COMTIM plant in Timiș in 2004 and is growing about 1.3 million pigs yearly showed its intentions to increase the number of pigs delivered by their farms and the volume of Romanian pork products made entirely from local production, based on pigs' vaccination campaign [16]. In Romania the decline of pig livestock reached 10 consecutive years. As previous studies showed [15] this decline is not only related with the ASFV crises, but has deep connexions with the low financial support of pig breeders and without a strong financial support of the sector, Romania will continue to import most part of the pork meat, in order to cover the internal demand for pig meat consumption. The effects of African Swine Fever in Romania, reported since the summer of 2017 [1], continued to multiply between 2018 and 2020 [10]. From the National Sanitary Veterinary and Food Safety

Authority of Romania reports we can notice that 543 thousand pigs were sacrificed in until the end of 2019 [2] while only in 2020 more than 194 thousand pigs were sacrificed in order to stop the spread of ASFV [3].

The data related with the evolution of the disease in 2021 are not final, but if we analyse the number of outbreaks, we can find that if in 2019 were recorded 1,728, in 2020 their number decreased to 1,063, but a worrying new evolution has taken place in 2021 when until the end of September was recorded the incident of 1,378 new outbreaks [4].

After 5 years with many outbreaks of the virus, the new context gives hope at least for the largest Romanian pig producers in relaunching their development.

Since the ASFV can be transmitted via direct or indirect contact [9] the main problems of the pork sector in Romania will be related with the virus spread between domestic and free-living pigs and will affect more the smallholder communities for which the poor biosecurity makes them fragile in the fight with ASF virus.

This paper aimed to make an update of the evolution of the pork sector in Romania, being a continuation of previous articles of the authors in connection with this subject, but using a different method of data processing and interpretation, and also focusing only on livestock.

MATERIALS AND METHODS

The paper analysed the evolution of the pig livestock and live weight of the pigs for slaughter. The research was conducted at the regional and national level, for the period 1990-2020.

Evolution of the pig livestock was represented in tables that included reference years of the analysed period. For this study we calculated the mean, the standard deviation, the coefficient of variation, the annual rate, and the evolution of the 2020 related with 1990, both for the pig livestock and for the live weight of the pigs for slaughter. The data were provided of National Institute of Statistics.

RESULTS AND DISCUSSIONS

The evolution of the pork sector in Romania was affected in first part of analysed period by the transition from a planned economy to a market economy which produced many changes in the production sector, related with the first significant reduction of pig livestock and the shift of the production from the state to the private sector. The integration of Romania within European Union in 2007, produced the second wave that contributed to the reduction of the pig livestock, but some benefit appeared in relation with the development of performant enterprises specialized in the pig production and the improvement of animal conditions in the farms.

But the summer of 2017 brought one of the most difficult challenge that affected the entire pork sector, related with the spread of AFS virus both in the small and large pig farms. The data provided by the European Commission indicated that Romania had in 2021 a number of 1,119 ASF outbreaks in domestic pigs, followed by Poland with 71 outbreaks, from a total of 1,207 cases at the EU level. More than that, between 2019 and 2021 was the most affected country of the EU at the farm level. Also, Romania had a significant number of ASF cases recorded in the wild boar.

Romania recorded a decrease of over 68% of pig livestock between 1990 and 2020, from 12 million heads in 1990 to 3.7 million heads in 2020. While in 1990 the South Muntenia was the region with the largest pig livestock of over 2.5 million heads, in 2020 the West Region was in the first position with 0.9 million heads. It can be also noticed that if in 1990 all the Romanian regions, excepting Bucharest Ilfov had over 1 million pigs (Table 1.), in 2020 not even one region has reached this threshold. From 2007 to 2020 only the West Region managed to maintain an appropriate level of pig livestock, while regions as North East, South East or South Muntenia suffered huge reductions of pig livestock.

For this period the annual rate was -3.77. The average pig livestock for the period 1990-

2020 was 6.3 million heads, the dispersion of the data set relative to its mean generated a standard deviation of 2 million heads. This conducted to a coefficient of variation of 0.32 at national level. While for the Bucharest Region the decrease of over 96% is self-understood by the urbanization trend, the decrease of over 79.9% in the South Muntenia Region and of over 73.3 % in the South East Region indicates that at least in these regions the consumption of pork meat can only be covered by considerable imports and the pressure on pork prices are significant due to high level of pork consumption in these regions. Within the regions, the Centre Region had the highest mean of pigs' livestock, of 853 thousand heads for the period 1990-2020, followed by South Muntenia Region, with 851 thousand heads and West Region, with 717 thousand heads.

Table 1. The evolution of the pig livestock in Romania between 1990 and 2020 (heads)

	1990	2000	2007	2016	2017	2018	2019	2020
Romania	12,003,384	4,797,357	6,564,907	4,707,719	4,406,014	3,925,283	3,834,136	3,784,507
North West Region	1,430,800	825,575	885,048	624,440	564,142	526,530	560,871	547,087
Centre Region	1,131,000	605,228	760,518	456,815	400,891	374,759	372,419	382,534
North East Region	1,458,600	660,421	806,138	488,421	458,394	447,482	381,248	425,284
South East Region	1,759,300	568,980	885,476	739,728	723,825	468,624	482,007	468,669
South Muntenia Region	2,574,700	791,556	1,131,926	832,781	753,815	649,680	583,808	515,742
Bucharest - Ilfov Region	344,800	138,568	191,647	33,083	27,324	23,610	10,002	12,144
South West Oltenia Region	1,184,700	569,019	936,132	588,082	558,292	519,960	499,081	483,415
West Region	2,119,500	638,010	968,022	944,369	919,331	914,638	944,700	949,632

Source: National Institute of Statistics, 2021 [14].

The highest standard deviation within regions was recorded in the Bucharest -Ilfov Region, of 475 thousand heads, while the smallest was recorded in the South West Oltenia Region, of 91 thousand heads (Table 2).

Table 2. Indicators calculated in relation with the evolution of the pig livestock in Romania for the period 1990-2020

	MEAN	STDEV	COEF. OF VARIATION	ANNUAL RATE	2020/1990
Romania	6,319,591.19	2,055,983.56	0.33	-3.77	-0.68
North West Region	6,130,131.43	1,794,913.33	0.29	-3.15	-0.62
Centre Region	853,106.90	217,294.30	0.25	-3.55	-0.66
North East Region	658,411.10	194,593.53	0.30	-4.03	-0.71
South East Region	714,923.23	217,382.05	0.30	-4.31	-0.73
South Muntenia Region	851,536.57	286,081.18	0.34	-5.22	-0.80
Bucharest - Ilfov Region	1,147,750.30	475,934.76	0.41	-10.55	-0.96
South West Oltenia Region	153,384.63	91,221.61	0.59	-2.94	-0.59
West Region	717,965.57	153,047.54	0.21	-2.64	-0.55

Source: own calculation based on INSSE data base [14].

The coefficient of variation was consequently the highest in the South West Oltenia Region, of 0.59, while the smallest was calculated for the West Region, of only 0.21. The annual rate varied within regions, between -10.55 in the Bucharest Ilfov Region, and -2.64 in the West Region (Table 2).

Regarding the evolution of weight for the pigs for slaughter, between 1990 and 2020, this decreased from 10.1 million to in 1990 to 4.9 million to in 2020. In 2007, the year of integration of Romania in the European Union, the weight of the pigs for slaughter already decreased to 6.4 million tons.

At the region level, the West Region had the highest weight of live pigs for slaughter in both in 1990 and 2020, of 222 thousand to, respectively 167 thousand to. Three regions recorded in 2020 a quantity of over 60 thousand to of the live pigs for slaughter: 66 thousand to for the South Muntenia Region, 65 thousand to for the North West Region and 60 thousand to for the South East Region. The weight of the live pigs for slaughter in the Bucharest - Ilfov Region indicates that this one is no longer significant for the pig production (Table 3).

Table 3. Evolution of the weight of live pigs for slaughter in Romania between 1990-2020 (tons)

	1990	2000	2007	2016	2017	2018	2019	2020
Romania	1,010,045	669,783	641,505	588,085	583,146	549,806	512,492	498,098
North West Region	114,847	98,188	85,521	81,779	79,797	74,274	70,353	65,618
Centre Region	96,373	82,414	80,267	62,544	69,504	55,543	50,446	43,352
North East Region	121,209	87,708	74,786	71,863	59,989	58,513	51,564	56,013
South East Region	120,951	76,493	84,879	81,503	82,767	72,216	62,207	60,002
South Muntenia Region	213,241	140,444	109,838	84,935	86,176	77,140	72,744	66,674
Bucharest - Ilfov Region	32,407	19,651	20,401	3,750	3,121	1,957	1,318	1,490
South West Oltenia Region	87,790	86,408	79,438	49,762	51,676	46,584	41,433	37,662
West Region	223,227	78,477	106,375	151,949	150,116	163,578	162,427	167,286

Source: International Trade Center and own calculations [11].

The results for the indicators related with the evolution of the pigs' weight for slaughter indicated that the mean at the national level was established at 7 million to, with a standard deviation of 177 thousand to. For the period 1990-2020 the coefficient of variation at national level was 0.25 and the annual rate was negative, of -2.33 (Table 4).

Table 4. Indicators calculated in relation with the evolution of the pigs' weight for slaughter in Romania for the period 1990-2020

	MEAN	STDEV	COEF. OF VARIATION	ANNUAL RATE	2020/1990
Romania	700,253.06	177,615.46	0.25	-2.33	-0.51
North West Region	689,926.67	170,925.22	0.25	-1.85	-0.43
Centre Region	91,184.40	21,316.85	0.23	-2.63	-0.55
North East Region	78,055.83	19,693.43	0.25	-2.54	-0.54
South East Region	80,985.30	22,802.27	0.28	-2.31	-0.50
South Muntenia Region	89,059.30	18,900.89	0.21	-3.80	-0.69
Bucharest - Ilfov Region	128,460.90	51,656.32	0.40	-9.76	-0.95
South West Oltenia Region	20,319.60	12,879.78	0.63	-2.78	-0.57
West Region	69,199.80	17,823.64	0.26	-0.96	-0.25

Source: International Trade Center and own calculations [11].

Comparing the evolution of the pigs' livestock with the evolution of the weight of live pigs for slaughter we can assume that the productivity has increased in the analysed period.

CONCLUSIONS

Romania is still the main affected country by the African Swine Fever from the European Union. The pig livestock continued to decrease and only the West Region could maintain their pig livestock at a level around 1 million pigs. The weight of the life pigs for slaughter also decreased during the 1990-2020, but not in the same measure, which that might be related with an increase of the pork sector efficiency.

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CONSIDERATIONS REGARDING THE DEVELOPMENT OF A SPECIFIC SPECIMEN FOR THE ANALYSIS OF COSTS IN AGRICULTURE

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Abstract

The purpose of the research presented in this paper is to develop a specific sample model for the analysis of costs in agriculture which was done by: 1. Scientific documentation to determine the main criteria to determine the relevance of including farm size ranges in the sampling structure; 2. sensitivity analysis in order to measure the impact of each criterion on farm-specific economic performance; 3. Interviews with farmers from a representative sample for the evaluation of farms by size categories; 4. restructuring the size ranges. The field researches were carried out in the second half of 2020, on two development regions of Romania: NE and SE. The average general score obtained by the entire sample is 4.7, which resulted in a structure of agricultural farms in economic size consisting of V intervals with the following limits: 100,000 SO, 250,000 SO, 500,000 SO, 750,000 SO, 1,000,000 SO.

Key words: *agricultural structures, cost analysis, sampling techniques, economic dimension*

INTRODUCTION

In Romania, agriculture plays an important socio-economic role. Most people with below average incomes in Romania live in rural areas and earn their living from agriculture or agriculture-related activities. People living in rural areas over the age of 16 are 5% more likely to be poor than those living in urban areas. Also, those who live in rural areas and work in agriculture are 27% prone to be poor [29].

An important problem of agriculture is the fragmentation of land which is significantly more correlated with the diversification of households. They use a higher proportion of agricultural production for self-consumption than for more market-oriented households. Therefore, it could be assumed that land fragmentation has led to a more diversified food basket for self-consumption among subsistence farmers, thus increasing their nutritional security [5].

While the number of farms decreases, the average farm size increased to 3.66 ha/farm in Romania and 16.1 ha EU-28. Approximately 0.57% of farms with more than 50 ha work 52.43% of the land used. The economic performance of Romanian agriculture is the lowest in the EU at a value of approx. 3.30 thousand euro/farm, 10.7 times lower than the EU average. About 83% of farms produced less than 4,000 euros/farm. The inequality of the concentration of farms in Romania is attested by the value of Gini 0.582, with a concentration index of 73%, which shows that the first 10% of farms manage a very large agricultural area, compared to farms belonging to other size classes. Romania occupies the following positions in the EU-28 ranking: 1 for farms (33.6%), 6 for the area used (7.47%), 26 for the size of the average farm (3.6 ha), 27 for the number of farms with more than 50 ha (0.57%), 20 for the area owned by farms with more than 50 ha (52.13%), 28 for production/standard farm (Euro 3.3 thousand), 6 for contribution to standard production of the EU, 6 to the value of the Gini coefficient and the concentration index that included the country in the sharp double category. Thus, the structure of the farm and the concentration of land in Romania is oriented on a good trend, but the optimal size of the farm will be achieved in the long run. This could ensure greater economic efficiency [20].

The evolution of agricultural production systems worldwide is influenced by the globalization of international trade in the current stage of socio-economic development, which amplifies the structural interdependence for the economies of different regions. For this purpose, it is necessary to analyze the evolution of production structures in the plant and animal sector of agriculture [13].

In Romania, the existence of a great diversity of farms is highlighted, which no longer falls strictly within a regular, desirable and legally defined typology. This situation reflects the correlation between the area used, the financial opportunities of the production cycles, the technical endowment and the intensification of the agri-food market activity [4].

The evolution of productions is characterized by an accentuated dynamics. Maize and wheat production has increased 2.8 times in the last decade, representing 50% and 38.5% respectively in cereal production. Romania ranks 2nd in corn and 5th in wheat in EU production. The increase in production is mainly due to the large cultivated area, 4.7 million ha, for these two cereals which represent 85% of the cultivated area in Romania. But, with 4.1 tons of corn and 3.9 tons of wheat per ha, the yield is 42.39% and 26.22% lower than the EU average, respectively. Romania has exported 11 times more corn and 34 times more wheat in the last decade. It also imported less corn, but more wheat, mainly for re-export. The Export/ Production ratio increased from 0.32 for maize and 0.82 for wheat, and the Export/ Import ratio reached 7.78 for maize and 5.83 for wheat. The value of exports and imports also had a high growth rate, while imports declined, resulting in a positive balance, both below the decrease in the export price and the increase in the import price [19].

Romania was highlighted as the main producer and exporter of sunflower in the EU (about 24% of the total area harvested and that about 25% of total production). The approach of the subject aimed at highlighting the differences between the 8 existing development regions at national level, in Romania. The price is characterized by a multiannual national average of 1.39 lei/kg, with limits of 0.99 lei/kg for the West Region in 2014 and 1.61 lei/kg for the South Muntenia Region in 2016. If we look at indicator in light of its evolution over time, we see the existence of fluctuating trends [18].

According to the National Institute of Statistics, for plant production in 2018, the largest shares were held by development regions: South-Muntenia 20.3%, South-East 19.1% and North-East 14.9%. Traditionally, the South-East Region is a predominantly agricultural sector. Conditions in the region favor the cultivation of maize (mainly in the north), wheat (mainly in the center of the region), spring barley, plants for industrial processing and sunflower. Yields per hectare for these crops are usually higher than national averages. Also, it has worked to improve the land in the "Lakes Braila" which resulted in 76,700 ha of land available for agricultural use in alluvial "Big Island of Braila" [15].

Agricultural exploitation there are general tendencies to assess the commercial aspect, but the social aspect of agricultural exploitation without a legal status, representative for small farm households, must also be recognized [3].

To improve the economic and environmental sustainability of agriculture, information is needed to support research, teaching, and information dissemination programs [27]. However, conducting field research in general, and in particular with agricultural producers, is becoming increasingly difficult, given issues such as declining response rates and limited resources. While there are studies examining best practices for promoting higher response rates, few explicitly focus on agricultural producers [22]. Providing incentives such as providing free use of databases for farmers' use can increase response rates to agricultural producers [2].

Following the review of the literature, it found that researchers show a growing interest in western EU cooperation in agriculture and alternatives to implement it in other areas [14] [22].

Farmers also need information on land preparation, soil fertility management, new varieties and hybrids, crop protection, harvesting techniques, pest and disease control, fertilization, crop rotation techniques, labor consumption, agrochemicals, irrigation management, application of pesticides. Farmers rely heavily on their previous experience and interpersonal relationships, such as colleagues/friends, progressive farmers, for agricultural information. Lack of timely access, inaccessibility, lack of awareness, rare visits by staff from information institutions, low level of education and language barriers are primary obstacles in acquiring information [16].

Research has shown that interaction and exchange of knowledge from multiple sources, especially from the actors in the production value chain, promoting the adoption of new technologies and best practices, thereby improving productivity and farmers' income [21].

Recent technology adoption literature has established the role of innovation as an interactive process, involving individuals and organizations with different types of knowledge in a particular social and institutional context [11]. Consequently, farmers' participation in expansion programs and technology adoption efforts has been described as a "co-creation of innovation [28]. firm, in terms of product, processes and practice, is now a key aspect of overall development [25].

Knowledge also provides tools for increasing performance based on the analysis of tax information [30]. The size and structure of expenditures differ depending on the type of production, the system practiced, the technologies used, etc., but regardless of the situation, the main problem to be pursued remains the optimization of the structure of expenditures so that their level determines maximum effect on production [31].

Table 1. Agricultural structures approved by the EU

Clase	SO (euro)	Agricultural area (ha)	The economic dimension (SO în 2019)
I	< 2 000	2.1	1,284
II	>=2 000 şi<4 000	4.2	2,930
III	>=4 000 şi<8 000	11	5,248
IV	>=8 000 şi<15 000	16	11,983
V	>=15 000 şi<25 000	22	18,244
VI	>=25 000 şi<50 000	57	34,950
VII	>=50 000 şi<100 000	121	74,087
VIII	>=100 000 şi<250 000	231	167,433
IX	>=250 000 şi<500 000	781	378,172
X	>= 500 000 şi<750 000	970	590,747
XI	>=750 000 şi<1 000 000	1,397	823,325
XII	>=1 000 000 şi<1 500 000	1,434	1,225,248
XIII	>=1 500 000 şi<3 000 000	2,704	1,922,952
XIV	>=3 000 000	5,132	4,584,656

Source: The regulation l (CE) Nr. 1242/2008 [8].

Quantitative research aimed at carrying out cost analysis in the plant sector of national agriculture requires the use of coherent sampling procedures. The models of sampling structures proposed by the international literature and EU bodies (Table 1) are unsuitable for in-depth research into cost analysis. This phenomenon is due to the deficient information system in small and medium-sized farms, on the one hand, and the fragmentation of economic entities or the integration of processing and animal husbandry sectors in large farms, on the other hand [32].

MATERIALS AND METHODS

The purpose of the research presented in this paper is to develop a specific sample model for the analysis of costs in agriculture. The objectives of the paper are:

(1)Determining the main criteria to determine the relevance of including the size ranges of farms in the sampling structure;

(2)Analysis of the impact of each criterion on the economic performance specific to farms;

(3)Evaluation of farms by size categories;

(4)Restructuring the size ranges. They also represented the research stages presented in this article.

The field researches were carried out in the second half of 2020, on two development regions of Romania, NE and SE, which include 12 counties and are located from the northern end to the southern end of Romania.

1. The determination of the main criteria to determine the relevance of including the size

ranges of farms in the sampling structure consisted in documenting from the literature on the main issues related to the collection of information for economic research in agriculture.

2. The analysis of the impact of each criterion on the economic performance specific to farms was performed through the sensitivity analysis that highlighted the variability of gross profit depending on the variations determined by the total, partial or non-fulfillment of each criterion.

This analysis also allowed the determination of the threshold from which the overall score of the size category is considered relevant for the cost analysis.

3. The evaluation of farms by size categories was conducted in interviews with 124 farmers in the NE and SE development regions of Romania in the fourth quarter of 2020. The criterion "% of marketed production" was determined on the basis of the share of marketed production (with values from 0 to 1) and the other criteria were given the value "1" for fulfilling the criterion and "0" for not fulfilling it.

4. Restructuring of the size ranges was to be performed only if the overall score obtained by one or more size ranges was lower than the threshold set for the sensitivity analysis.

The entire field research was conducted by face-to-face interview and by telephone in the last half of 2020 on a representative sample. Sampling was performed by the Neyman method, a deviation criterion of 5% and a confidence level of 95%. Computer applications such as MS Excel, SPSS (Kolmogorov – Smirnov test, t-test) were used for data processing.

RESULTS AND DISCUSSIONS

The first stage of the research was to determine the main criteria by which to determine the relevance of including the size ranges of farms in the sampling structure. This consisted of documenting from the literature on the main issues related to the collection of information for economic research in agriculture. Among them were highlighted aspects related to the accounting, technical and management information recording system. These allowed the determination of criteria according to which to evaluate the vegetal farms by size categories. Meeting these criteria establishes that the farms surveyed can provide sufficient and consistent information on cost formation.

Table 2. Determination of the weight of evaluation criteria based on the variability analysis indicated sensitivity (5%)

No.	Evaluation criteria	gross profit variability (%)	variability in total criteria (%)	The importance of the criterion of coefficient
2	accounting records	4.41	8.88	0.89
3	technological records	3.78	7.61	0.76
4	economic records	3.41	6.85	0.69
5	highlighting implicit expenses	5.17	10.41	1.04
6	highlighting the costs of supply	3.72	7.49	0.75
7	highlighting marketing expenses	4.48	9.01	0.90
8	highlighting works and maintenance expenditures	5.23	10.53	1.05
9	% of marketed production	4.86	9.78	0.98
10	main objective - economic performance	4.92	9.90	0.99
11	shareholding company exclusively researched	9.71	19.54	1.95
	Total	49.69	100.00	10.00

Source: Own calculation.

Farms that belong to certain size categories and do not sufficiently meet these criteria will be grouped with the others. Basically, some size ranges will be cumulated because representativeness cannot be obtained for them.

The scientific documentation revealed 12 criteria, those presented in Table 2 of which a criterion regarding the highlighting of capital expenditures. This criterion was abandoned because capital expenditures are evident in the accounting records - criterion 2. There were

11 criteria (Table 3) that directly concern the accuracy of the information needed for cost analysis.

The second stage, the analysis of the impact of each criterion on the economic performance specific to the farms was performed through the sensitivity analysis. It highlighted the variability of gross profit depending on the changes determined by the total, partial or non-fulfillment of each criterion.

The sensitivity analysis applied to a 5% input data variability indicated a total change in gross profit of 57.33%. It was weighted as variability from the total criteria and resulted in a set of coefficients of importance of the criteria from 0.59 for the criterion “economic records” to 1.69 for the criterion “shareholding exclusively in the researched company”.

Table 3. Main criteria for including farm size ranges in the sampling structure

No.	Evaluation criteria	Source
1	agriculture - main activity	[12; 26]
2	accounting records	[10; 17]
3	technological records	[7]
4	economic records	[23]
5	highlighting implicit expenses	[1]
6	highlighting the costs of supply	[9]
7	highlighting marketing expenses	[10]
8	highlighting works and maintenance expenditures	[6]
9	% of marketed production	[24]
10	main objective - economic performance	[12]
11	shareholding company exclusively researched	[1; 9]

Source: Own calculation.

This analysis also allowed the determination of the threshold of the general score from which the size category is considered relevant for the cost analysis at a value of 5.00 points. This value is determined by the correlation between the mean variability per criterion (5.21%) and the 95% confidence level after which the Neyman sampling method was applied. The third stage, the evaluation of the farms by size categories was performed based on the information taken from the interview on a representative sample. The evaluation of the farms according to the criterion “agriculture - main activity” (Fig. 1) indicates that in 33.6% of the surveyed farms agriculture represents the basic activity of the household or economic unit. Only 2.7% of farms with a size between 2,000 and 50,000 SO and 22.7% of farms with an economic size of more than 75,000 SO do agriculture as their main activity. The first category is represented by peasant households or small farms that have several activities, including agriculture. They use agricultural products obtained for the family's own needs or to supplement the income obtained from other fields of activity. The second category, medium and large farms, usually have legal status but have a diversified production structure that includes animal husbandry, seed production, its conditioning, trade or other services. The accounting records are specific to farms with legal status and are regulated by the legislation in force. These are usually medium and large entities, over 100,000 SO.

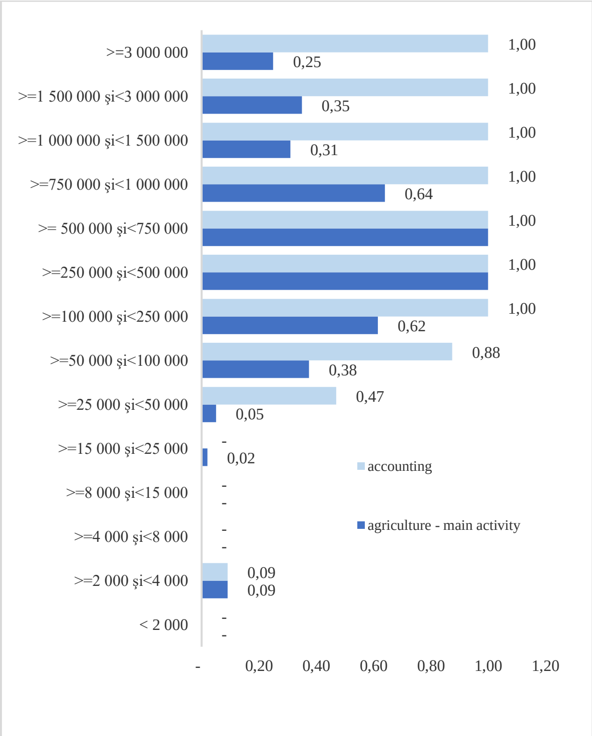

Fig. 1. Evaluation of farms according to the criteria "accounting" and "agriculture - main activity"
Source: Own calculation.

The criterion “economic records” (Fig. 2) is met by 44.7% of the surveyed farms. Farms with a size of less than 50,000 SO in a proportion of 95.3% do not make economic records. Those with an economic size of over 75,000 SO make these records only in proportion of 16.7% because the complexity of the activity requires a large volume of work and economic skills to achieve this information system. Technological recordings are more often made, in a proportion of approx. 57.3% and are achieved mainly through technology sheets and crop budgets. The economic data contained in them are often strictly indicative but the technical ones rigorously specify the period of completion of the works, the surfaces, the physical need for inputs and other important information.

The evaluation of the farms according to the criterion "highlighting the supply costs" (Fig. 3) indicates that 58.7% of the surveyed farms determine the supply costs.

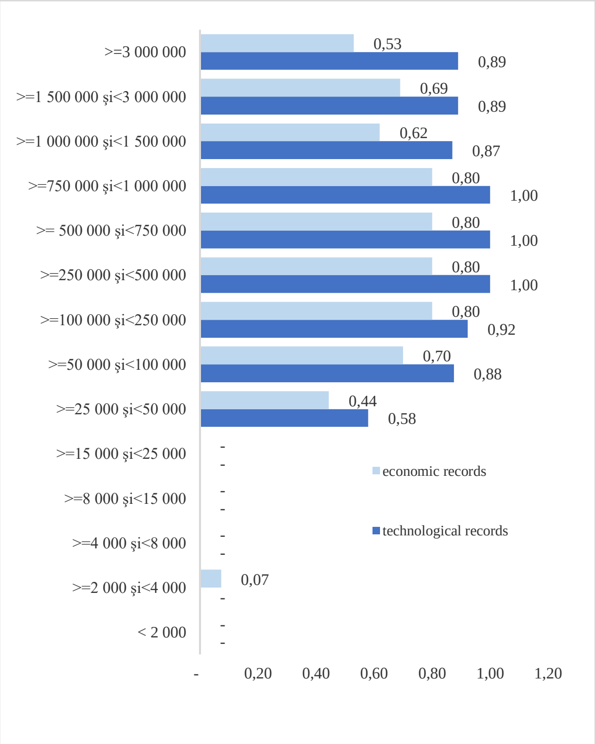

Fig. 2. Evaluation of farms according to the criteria "economic records" and "technological records"Source: Own calculation.

Some of them have a system of accounting records and can make these calculations or others record these expenses in the production activity although they do not have accounting records. Only 1.5% of farms with a size of less than 25,000 SO highlight supply costs. A percentage of 61.3% of farms with an economic size of over 75,000 SO, higher than the average value of the sample but 13.4% lower than farms with sizes between 50,000 SO and 1,000,000 SO. Determining the implicit costs requires knowing the tariffs for agricultural services available in the area to which each farm has access. The best alternative that has been abandoned by carrying out various self-directed activities changes from one year to another. Thus, farms must create a dynamic database comprising suppliers in their area and adapt this database at least annually. Only 7.9% of the researched farms make these databases, most of them in the size range 500,000 SO - 750,000 SO (30.8%).

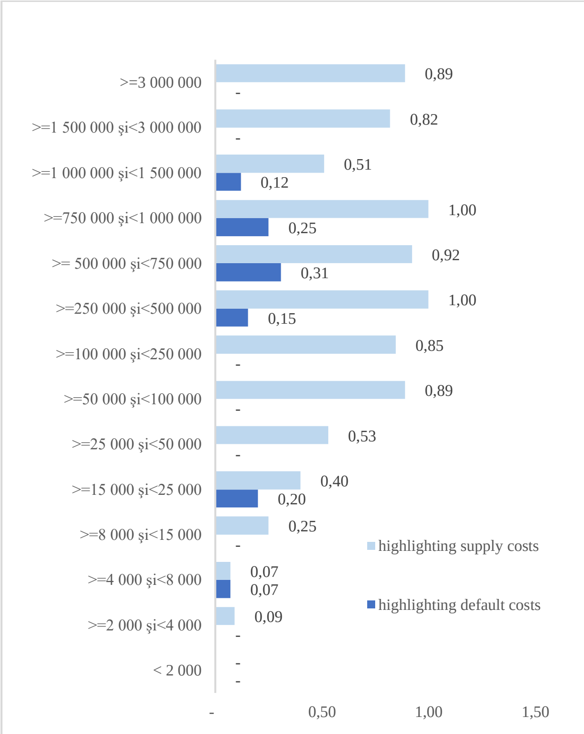

Fig. 3. Evaluation of farms according to the criteria "highlighting supply costs" and "highlighting default costs"
Source: Own calculation.

Highlighting the costs of servicing the works (Fig. 4) is done in 59.0% of the farms surveyed with the lowest value (9.0%) in the case of farms below 25,000 SO. The evaluation of the farms according to the criterion "highlighting the marketing expenses" shows that 63.3% of them have information about the marketing expenses and the rest do not consider them necessary or priority.

Economic performance is not a priority for 65.2% of farms (Fig. 5) because small farms produce for their own consumption most of the time and many medium and large farms are concerned with increasing agricultural area, increasing the level of capitalization, increase the volume of activity or simply do not have sufficient economic skills.

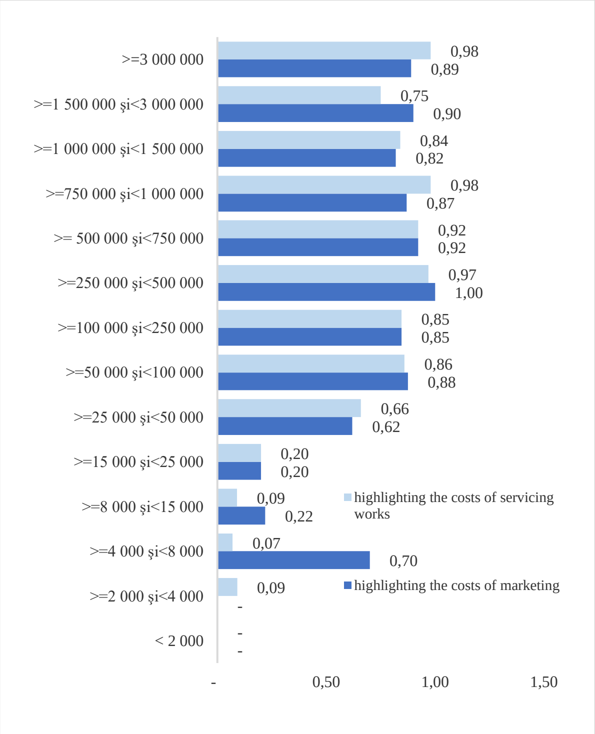

Fig. 4. Evaluation of farms according to the criteria "highlighting the costs of servicing works" and "highlighting the costs of marketing"
Source: Own calculation

The criterion "% of marketed production" shows that 55.9% of the sample production is marketed, agricultural products from small farms below 50,000 SO are used in a proportion of approx. 86.0% for self-consumption. And farms larger than 1,000,000 SO sell only part of the production (59.7%) because the rest is used as input for other activities such as animal husbandry or product processing.
The evaluation of the farms according to the criterion “shareholding exclusively in the researched company” (Fig. 6) indicates that 58.3% of the researched farms have owners who do not own other economic activities. The first ten categories with dimensions of up to 75,000 SO have only this activity in a majority proportion of 74.2%.
The other higher categories in size are owned by people with superior entrepreneurial skills who seek to maximize the efficiency of investments.
As the minimum threshold required to include a size range is 5.00, it is necessary to reshape the size structure of agricultural holdings needed to determine costs.
The last stage involved the cumulation of size ranges with values below the threshold of 5.00 at neighboring ranges to ensure their relevance in cost analysis.

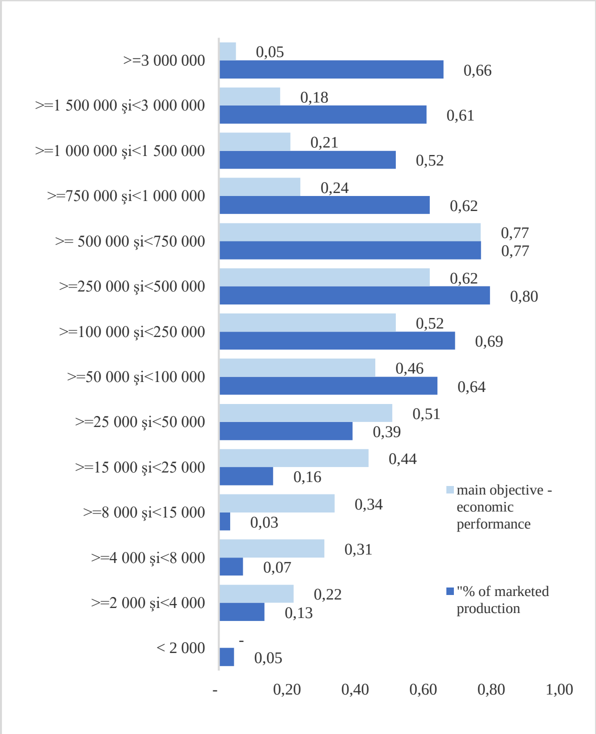

Fig. 5. Evaluation of farms according to the criteria "main objective - economic performance" and "% of marketed production"
Source: Own calculation.

Thus, intervals I-IV were cumulated with interval VI because it obtained a score of 6.39 and intervals XII-XIV were cumulated with interval XI because the latter obtained a score of 6.17.
Consequently, the result was a structure of agricultural farms with an economic size consisting of V intervals: interval I with a size of less than 100,000 SO; interval II with a size between 100,000 SO and 250,000 SO; interval III with a size between 250,000 SO and 500,000 SO; interval IV with a size between 500,000 SO and 750,000 SO and interval V with a size greater than 1,000,000 SO.

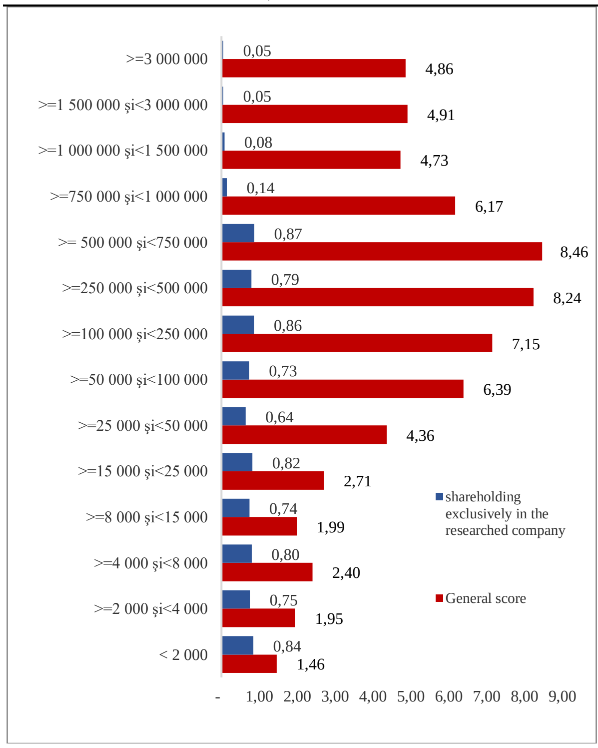

Fig. 6. Evaluation of farms according to the criteria "shareholding exclusively in the researched company" and "General score"
Source: Own calculation.

CONCLUSIONS

After the evaluation of the farms in the sample, it was determined that 33.6% of them have agriculture as their main objective.
Small and medium farms have more activities in addition to agriculture, use agricultural products for the family's own needs or sell them to supplement the income obtained from other areas of activity.
Large farms have a diversified or integrated production structure. The accounting records are specific to farms with legal status and the economic records are made by approx. 44.7% of farms.
Technological records are found at approx. 57.3% of farms instead the opportunity costs can be determined at 7.9% of them.
Expenses for servicing the works are registered in 59.0% of the cases and those for marketing in 63.3% of them. Economic performance is a priority for 34.8% of farms because small farms produce for their own consumption and medium and large farms are concerned with increasing agricultural area, increasing the level of capitalization, etc.
The percentage of marketed production at the level of the sample is 55.9%, the rest being intended for self-consumption or used as raw materials for integrated activities.
Approx. 58.3% of farms owned exclusively in the unit because the other higher categories in size are owned by people with superior entrepreneurial skills who seek to maximize investment efficiency. The average general score obtained by the entire sample is 4.7, which resulted in a structure of agricultural farms in economic size consisting of V intervals with the following limits: 100,000 SO, 250,000 SO, 500,000 SO, 750,000 SO, 1,000,000 SO. Such a structure provides a sufficient information system for cost analysis in agriculture.

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The study is part of the Type D collaboration activities - Industrial research and/or experimental development activities carried out by the research organization in effective collaboration with the enterprise, Sub-activity D.1 Industrial research activities.
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THE INFLUENCE OF ORANGE JUICE ON MITOSIS AND IN VITRO GROWTH TO *HIBISCUS ESCULENTUS*

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Abstract

The regeneration capacity of the cells of an explant depends on several factors: the nature and origin of the explants, their type, structure and degree of juvenility, cell maturity and physiological state, endogenous phytohormone content, composition of culture medium and culture conditions, etc. Among them, the culture medium is an essential factor for the success of in vitro culture. In its composition, in addition to macro and microelements, vitamins, sucrose, etc., can be added some natural nutritional extracts, such as deproteinated coconut milk or various vegetable and fruit juices, to improve the complexity of the culture medium. This paper presents the results obtained in the laboratory from the in vitro culture of okra (Hibiscus esculentus), on modified Murashige-Skoog culture medium (MS) by adding natural orange juice in three different concentrations: 5, 10 and 20%. It was observed that at the 10% concentration of orange juice were registered the highest values, both in terms of germination, explant growth and mitotic activity. The lowest values from this point of view were obtained at a concentration of 20%. These results suggest the nutritional potential of orange juice added to the MS culture medium to increase the growth rate and in vitro survival of okra via cells competence improvement.

Key words**:** *okra, in vitro, orange juice, culture medium, growth, mitosis*

INTRODUCTION

The beginning of the third millennium is characterized by the strong involvement of bioengineering and biotechnologies in agriculture but also in other fields of activity. Many problems related to the negative impact of pathogens on crops [15, 16, 17] can be solved by modern and sustainable improvement of the plants.

Food security is one of the global challenges of this century. Sustainable crop management has a strategic role, as it is responsible for food security with a special contribution to the overall process of sustainable economic development and environmental protection [8, 14, 19].

Due to the wide range of problems solved by in vitro cultures, they are currently used in agriculture, forestry, pharmacy, food industry, light industry, etc. In agriculture in general and in horticulture in particular, in vitro cultures are used for the multiplication of valuable species, varieties or clones, for the improvement of cultivated species, the conservation of horticultural germoplasme, obtaining secondary metabolites, etc.

On a synthetic nutrient medium can be grown whole plants, organs, organ fragments, tissues but also isolated cells and protoplasts. The plant material used to initiate in vitro cultures is called explant. The explant is actually the portion of the plant that is detaches from the donor plant and is inoculated under sterile conditions, on an artificial culture medium. The explant is the living unit that contains in the cells all genetic information of the mother plant and based on totipotency is able to regenerate one or more plants identical to the donor plant [22].

Unlike traditional multiplication, where it is operated with seeds or large portions of the plant, in vitro multiplication uses small explants, of the order of millimetres or even microscopic (cells, protoplasts) that under normal culture conditions would not be able to grow resisting to the pathogens and self-synthesizing the necessary nutrients.

Based on the concept of cell totipotency, according to which each cell contains the genetic information necessary to obtain by regeneration a complete plant organism, Murashige and Skoog (1962), managed to develop a culture medium considered basic, which, with small modifications, can be used for almost all types of in vitro cultures [12]. This culture medium is named after them: Murashige and Skoog (MS).

Phytovitrocultures are organized in conditions of strict sterility, similar to the technique of culture of microorganisms, but using different specialized culture medium to induce the plant regeneration. The culture medium represents the physical and chemical support necessary for the growth and development of in vitro explants [1, 21].

Some of the conditions that a culture medium must comply are [12]: to correspond to the nutritional and hormonal requirements of the cultivated species for the phase in which it is found (stabilization, proliferation, callogenesis, rooting, etc.); to ensure optimal conditions for growth and development in terms of osmotic pressure, pH, humidity; be ionically balanced; be easy to prepare and reproducible; be inexpensive and contain as few as possible expensive and inhomogeneous constituents.

The culture mediums used for plants vitroculture generally have a complex structure, being composed of a large number of constituents of diverse nature and with a different role [10]. These constituents can be grouped into:

a. Nutrient constituents: mineral elements: macro and microelements and organic elements: sugars (as a carbon source), amino acids (as a source of organic nitrogen) and vitamins;

b. Constituents with phytoregulatory role of growth and development of explants in vitro: auxins, cytokinins, gibberellins and other substances with stimulating or inhibitory role: abscisic acid, ethylene, colchicine, etc.;

c. Constituents with a role in stabilizing the culture medium: water, solidifying agents, osmotic and pH stabilizers, antioxidants and absorbents.

The culture medium used for static cultures also contains a gelling agent, which usually is the agar. MS culture medium can be modified by adding components or removing other components. From this point of view, various natural extracts can be added, for example; tomato juice, banana, melon, yeast extract, malt extract, etc. [2, 9, 18].

Okra (*Hibiscus esculentus*, synonymous with *Abelmoschus esculentus*) is part of the *Malvaceae* Family. It is an annual plant that grows up to 2 m in height; the leaves are 10–20 cm long and are broad, with 5–7 lobes. The edible fruit is a green capsule (8–20 cm long) and contains many seeds. Okra is grown in warmer tropical and temperate areas for its fibrous green pods, highly valued for their nutritional value, being an excellent source of vitamins, proteins and fibres [6, 10, 11].

Okra is one of the most heat- and drought-resistant vegetables and tolerates the clay soils. These advantages place it in the list of foods with high potential to ensure food security and safety, in the conditions of climate change recorded worldwide [4, 5]. It is desirable to multiply such resistant plants, in the context in which the major global crises, such as climate change or the pandemics, have serious repercussions on food security [13].

In vitro okra behaves very well, many results highlighting the importance of vitrocultivation of this species [6, 7].

MATERIALS AND METHODS

The methods and techniques of the plant biotechnology have several basic elements, such as: complex nutrient medium (culture medium), total asepsis of the culture medium, the plant material to be inoculated, instruments and controlled climate conditions.

The plant material for inoculation consisted of okra seeds which were disinfected with 0.25% sodium hypochlorite for 5 minutes and then rinsed three times with distilled water.

Three variants of MS culture medium (V1-V3) modified by adding fresh orange juice in three different concentrations were made: 5,

10 and 20%. The control variant consisted of conventional MS culture medium, with pH stabilized at 5.5 [12].
The plant material was inoculated into sterile Erlenmeyer glasses containing about 25 ml of agarized MS culture medium. 10 culture pots were made for each variant. The pots were closed with aluminium foil lids and were placed in the growth chamber, under fluorescent lamps with an intensity of 1,000 lux, for 16 hours/day at 25^0C, for 30 days.
The subculturing of each variant was performed on fresh culture medium, with the same composition corresponding to each variant.
Laboratory measurements were performed on the vegetative growth of the neoplants and the mitotic index was calculated by microscopic analysis of the meristematic tissues from the top of the neoformed roots at each variant. For this, the Feulgen-Rossenbech staining method was used and the microscopic preparations were analysed by the squash method [20].
For microscopic determinations was used the Optika digital microscope with LCD display.
Analysis of variance (ANOVA) was used for statistical calculation.

RESULTS AND DISCUSSIONS

A standard culture medium consists of a mixture of macro and microelements (chlorates, nitrates, sulfates, phosphates and iodates of Ca, Mg, K, Na, Fe, Mn, Zn and Br), vitamins, a carbon source, substances organic growth (amino acids, urea and peptones and a source of nitrogen). The addition of various plant extracts is done in order to stimulate cell mitosis and thus determine the improvement of plant growth in vitro.
In our experience, the in vitro germination percentage of okra on MS medium added with orange juice has values between 82.08 (Control) and 90.24 (V2) (Figure 1).

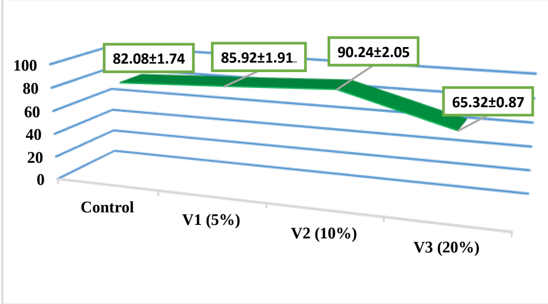

Fig. 1. Germination values (%) of okra on MS culture medium modified by the addition of orange juice in different concentration
Source: Own calculation.

From the point of view of vegetative growth, okra cultivated in vitro registered different values, depending on the concentration of orange juice added in the MS culture medium. Thus, the best results were identified in V2 variant, where the concentration of fresh orange juice added in the MS culture medium was 10% (Figure 2). The values obtained were 35% propagules regenerated after two subcultures (V2); 21% (V1) and 16% (V3). The value recorded by the control variant was 26%. It can observed that variant V2 exceeded the value of the control variant and the lowest values from this point of view were obtained at a 20% concentration (V3).

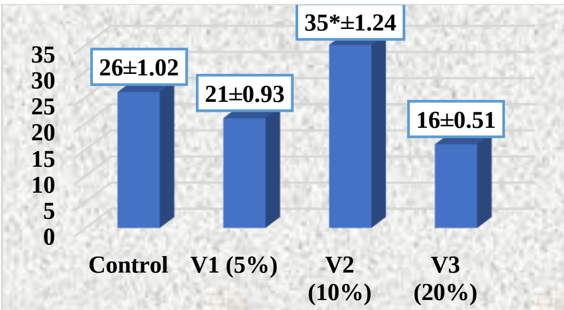

Fig. 2. Percentage of propagules regenerated in vitro after two subcultures to okra on MS culture medium modified by the addition of orange juice in different concentration
*Significant at $p \leq 0.05$ (ANOVA analysis)
Source: Own calculation.

Microscopic analysis of the cross section of the okra meristematic roots shows the presence of aerenchyma cells and air cavities (Figure 3).

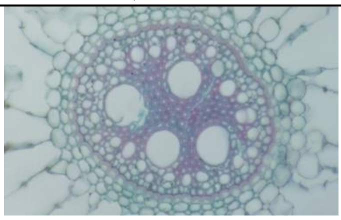

Fig. 3. Meristematic root (cross section) of okra visualised at digital microscope
Source: Own lab survey.

In terms of mitotic index (MI), variant V2 recorded the highest intensity of mitotic division (54.81%), followed by variant V1 (41.28%) and variant V3 (31.05%), which recorded the lowest mitotic activity , compared to the control variant, which recorded a mitotic index of 34.16% (Figure 4).

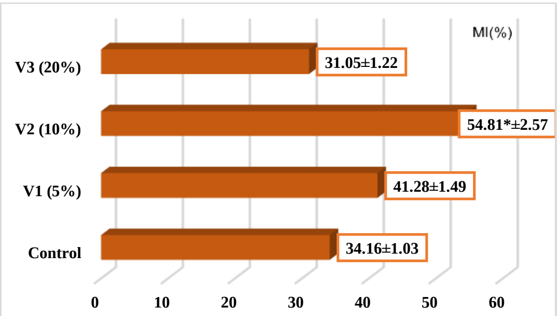

Fig. 4. Mitotic activity registered in meristematic roots of okra on MS culture medium modified by the addition of orange juice in different concentration
*Significant at $p \leq 0.05$ (ANOVA analysis)
Source: Own calculation.

In vitro plant culture pursues several objectives, some of the most important being the following: rapid and mass propagation of some varieties, preservation of genetic material from valuable genotypes, production of virus-free plants.
Any type of explant is characterized by a certain biochemical balance, depending on the age of the donor plant, its physiological stage, the organ from which it was collected, the structure and dimensions of the explant itself, etc. Also, the culture medium and especially its components have a major influence.
Regarding the complex substances that can be part of an in vitro culture medium, in many experiments a series of extracts were tested: protein hydrolysates [2], yeast extract [18], malt extract, tomato juice [9], coconut milk, sea buckthorn fruit extract [3], immature corn endosperm extract, etc. The importance of these types of complex substances is due to their natural origin, as well as the numerous mechanisms of action of the active substances contained, such as: flavonoids, alkaloids, glycosides, saponins, tannins, etc.
Given the importance of in vitro cultures for agriculture, horticulture or medicine, all strategies aimed at improving the use of nutrients in culture medium are justified. Thus, the acceleration of organogenesis processes and the shortening of the in vitro growth time can directly influence the profitability of production. The positive effect of phytogenic compounds on in vitro plant growth must also be evaluated in terms of the positive impact on the environment.

CONCLUSIONS

The culture medium used for inoculation and in vitro growth of explants have, in generally, a complex structure, being composed of a large number of constituents of various nature and with different roles. In terms of phytonutrients, a number of natural extracts can stimulate the growth and survival of plants in vitro.
The results obtained in this experience suggest the stimulating potential of orange juice for in vitro growth of okra. It is possible that the stimulating effect for mitotic division and organogenesis is due to the high content of biologically active polyphenolic compounds from the orange juice, arranged in easily accessible complexes to plant cells.
Orange juice added to the MS culture medium can thus reduce the risk of oxidative stress for in vitro phytocultures. However, further study is needed for clear conclusions.

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GENETIC BIOENGINEERING IN AGRICULTURE - A MODEL SYSTEM FOR STUDY OF THE MECHANISM OF PROGRAMMED CELL DEATH

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Abstract

The behaviour of in vitro cell cultures is different from that of in vivo cells, when they are integrated into the organism. The selective death of cells, tissues and organs is a feature of plant development and survival. The process is called programmed cell death due to the organism's involvement in controlling of the initiation and execution of this process. The programmed cell death is an active, genetically controlled process that leads to the selective elimination of damaged cells. This complex process is present throughout the life of plants, from the seed germination to the maturation and senescence of plants. Cell death in plants has specific features due to the cell wall in particular but also of the presence of some specific structures of the plant cell, such as chloroplasts and vacuole. Exposure of plants to various stressors can induce oxidative stress and can be followed by cell death. However, cell death under abiotic stress conditions can also be a regulated process, meant to ensure the survival of plants. The programmed cell elimination plays an essential role in the desired modelling of plants, and this goal is the prerogative of genetic bioengineering, via cell cultures. The fascinating field of genetic bioengineering has a huge potential for the programmed modelling of the plants and obtaining new genotypes, with superior properties and high capacity to adapt to different environmental conditions, corresponding to the requirements of a sustainable management of modern agriculture.

Key words**:** *genetic bioengineering, cell death, programmed modelling*

INTRODUCTION

The concept of genetic bioengineering is a set of methods and laboratory techniques that allow the manipulation of genetic material, without the participation of sexual processes, with the aim of obtaining new organisms with new combinations of hereditary characters. Through modern genetic bioengineering techniques, it is possible to transfer genes from one organism to another or from one species to another and even the synthesis of organisms with modelled or programmed characteristics. The plant bioengineering support is in vitro culture, represented by techniques for plant organs cultivation, tissues and cells on artificial medium. The term in vitro completes the notion in vivo, which is represented by the cellular elements integrated in the universal connections of a plant or animal organism. Exposure of plants to various stressors such as hypoxia, water deficit, UV radiation, salinity, extreme temperatures, pollutants, toxins, heavy metals, etc., can induce oxidative stress and can be followed by cell death. The phenomenon of cell death in plants is essential in their life cycle. Programmed cell death (apoptosis) is an active, genetically controlled process that leads to the selective elimination of unwanted or damaged cells in eukaryotes [1, 9]. Cell death and cell proliferation, cell growth and cell differentiation, are well coordinated processes, thus ensuring the maintenance of homeostasis of plants tissues and organs [8].

Cell death in plants was classified into three types, depending on the morphological characteristics expressed by the affected cells [5, 9]:

a) Apoptosis-like cell death involving rapid nucleus degradation and loss of cell organization, a phenomenon encountered

during plant development or under conditions of exposure to stressors. This form of degradation is signalled by mitochondria and is represented by nucleus shrinkage, chromatin condensation and DNA-laddering;
b) Cell death specific to plant senescence, a slow process associated with the recovery of cell content and the relocation of nutrients. After the complete degradation of the plastids, at the end of the cellular degradation process, occurs the nucleus and vacuole collapse;
c) Cell death induced by the collapse of the vacuole, which involves the action of proteases located in the vacuole, whose release into cytosol causes degradation of cell contents.
In vitro cell cultures are true systems for studying the mechanism of cell death in plants, due to the uniformity of the cultures, their accessibility and their low complexity. In this way, cell cultures reorient some directions of plant research, as well as certain concepts regarding the particularities of living matter.

MATERIALS AND METHODS

The death of specific cell sets is an essential part of plant and animal development. The phenomenon of programmed cell death in plants mean any process where the protoplast is removed as part of an event of cell development or adaptation in the life cycle of the plant. The process is called programmed cell death due to the fact that the organism controls the initiation and execution of this process. This review attempts to highlight some of the important issues on programmed cell death in plants and its presence throughout the entire life of plants, from the moment of seeds germination until their maturation and senescence. It is briefly presented how programmed cell death occurs during the vegetative growth of plants and their reproductive development, taking into account some factors of biotic and abiotic environment.

RESULTS AND DISCUSSIONS

Biotic stressors cause a multitude of processes in plants, which begins with the perception of stress by specialized receptors and ends with the expression of a battery of target genes [25]. Biotic stress produces effects both on primary metabolism and on secondary metabolism, reflected in the change in the activity of some enzymes, given that all chemical processes are catalysed by enzymes.
Reactive oxygen species are a normal product in the cellular metabolism of plants. A variety of environmental stressors lead to the overproduction of oxygen-reactive species, which cause oxidative damage and ultimately can cause cell death (Figure 1). In addition to their destructive activity, they are also described as secondary messengers in various cellular processes, including increasing plant tolerance to biotic and abiotic stress [25].

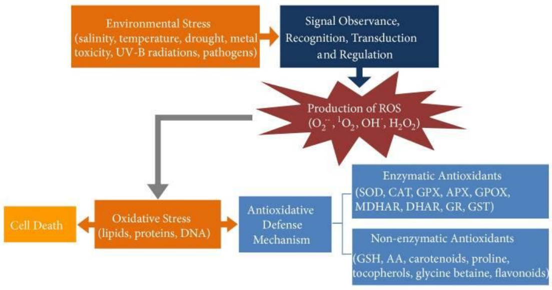

Fig. 1. The relationship between stressors, oxidative damage and cell death in plants
Source: [25].

Plants have a complex system of defence against oxidative stress, composed of enzymatic and non-enzymatic components for detoxifying reactive oxygen species. In plant cells, the systems for producing and detoxifying reactive oxygen species are found in various cellular organs, such as chloroplast, mitochondria and peroxisome. In fact, mitochondria play an essential role in promoting and achieving programmed cell death in plants.
The response of plants to abiotic stress is determined by several factors, such as their genotype and stage of development, as well as the duration, intensity, periodicity and synergistic effects of multiple stresses or pollutants [2, 3, 22]. In plants, stress triggers a wide range of responses, from altered gene expression and cellular metabolism to changes in growth rate and yield per unit area. From this point of view, sustainable crop management strategies reduce the negative

effects of various stressors, increase the chances of food security and at the same time protect the environment [2, 7, 16-21].

One example of programmed cell death like response of the plant to stress is the aerenchyma formation, a specialized tissue in cortical root cells located between the endoderm and hypodermis. The formation of the aerenchyma is a response to limiting the access of oxygen to the roots (hypoxic stress). This response leads to the removal of cortical cells from the root and forming a space that facilitates the movement of oxygen in the roots [4, 5, 9].

Another example of programmed plant cell death is the host plant's resistance to pathogens, translated by the rapid death of the host cell. This genetically programmed response is a consequence of new transcription and translation processes and is given by some incompatible interactions between disease-resistant plants and non-virulent pathogens. The whole process is controlled by resistance genes (R), which respond to pathogens that carry specific avirulence genes (Avr). In the absence of the R allele in the host and Avr in the pathogen, the disease sets in because the plant does not recognize the pathogen and takes place a compatibility reaction [9].

Host response is an active process that requires transcription and translation. Peptides and oligosaccharides produced by the pathogen or as a result of the pathogen-host interaction applied to a plant with have resistance genes induce some biochemical and cellular responses. However, cell death in a resistant host is not necessarily the result of direct toxic effects.

Many scientific results show that in plants, the response of cells to the pathogen is apoptosis [4, 9, 10, 15]. Although programmed cell death in plants has some similarities to apoptosis in animals, it still has important differences (Figure 2), as plants do not have an immune system and do not contain phagocytes, and the plant-specific cell wall prevents the formation of apoptotic bodies [4]. It is also considered that in plants apoptotic corpuscles would be functionally irrelevant, as their phagocytosis by adjacent cells would not be possible in the presence of cell walls [9].

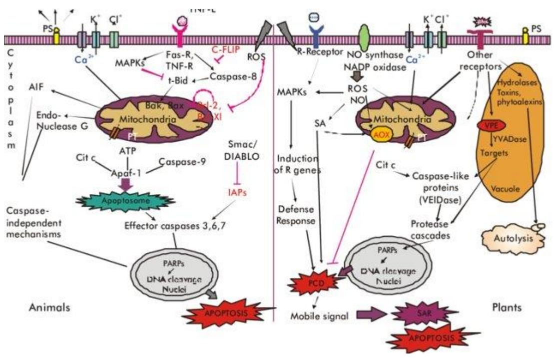

Fig. 2. Main mechanisms for programmed cell death in plants and animals
Source: [4].

Although some regulators of programmed cell death observed in animal systems have been identified in plants, the corresponding genes in plants have not yet been isolated. This may suggest that plants have developed other ways to control host resistance to various stressors and have also developed their own ways of regulating cell death processes that differ from those in animals.

Plant cells subjected to cell death synthesize self-destructing substances, which are placed in the vacuole, and rupture of the vacuole causes cell death. The condition of the cells can be monitored with fluorescein diacetate (FDA). The presence of fluorescence in cells shows that they are alive, and the absence of the phenomenon indicate cell death. If fluorescence is missing and condensation of the cytoplasm is present, it means that the cell has been subjected to cell death. In some in vitro experiences with animal tumour cells were identified near-infrared fluorescent carboxylate cyanine (NIRF) [24].

The cells at the root tips, which come from the initial cells of the meristem moved to the periphery by the newly formed cells, protect the apical meristem during seed germination and seedling growth. These peripheral cells die after a few days and this death is part of the normal development of the plant. Cells that die from the root tips shrink and take on different profiles [13].

Programmed cell death occurs in most plant tissue types and is involved in numerous processes, from seeds germination to plant senescence. Thus, when the seed germinates, hydrolytic enzymes are secreted from the aleuronic layer and the starch endosperm is degraded while the cells of the aleuronic layer remain alive. The programmed death of the cells of the aleuronic layer takes place gradually during germination, by progressive vacuolation, followed by the death and collapse of the protoplast. The cells of the aleuronic layer die via autolysis only after the starch reserves have been mobilized.

During the vegetative growth of plants and other structures or processes are accompanied or come by programmed cell death. Some of the most important plant development processes in which programmed cell death is involved are: embryo formation, degeneration of aleuronic layer, formation of root aerenchyma, anthers degeneration, pollen self-incompatibility, remodelling the leaves shape, leaf senescence, etc.

Sclerenchyma cells are dead and cell walls are thickened to perform mechanical function. The bark is made up of specific cells with a suberified cell wall to protect the internal tissues from dehydration (the protoplast of these cells is removed). The growth of the stem is also accompanied by cell death, the division of the cells in the cambium causing the death of the cells in the bark layer [15].

By the death of some sub-epidermal cells from the surface of the citrus fruits, are formed some cavities in which the essential oils are stored. The mechanism by which differentiation of secretory canals and cavities in which volatile oils are collected, found in many plant species, is called lysogeny [6]. Programmed cell death has also been observed in suspended embryogenic cultures in some plant species [12]. Totipotent cells divide asymmetrically and form pairs of cell one of which develop into a somatic embryo, while in the other it occurs the stop of DNA synthesis and her death.

Cell death also accompanies a number of processes specific to the reproductive development of plants, such as sex determination, gamete formation, fertilization and embryogenesis. Cell death occurs in various tissues and reproductive organs and sometimes even these organs are subject to extinction [8].

By programmed elimination of excessed cells in the processes of morphogenesis, cell death is involved in remodelling the shape of the plant leaves (Figure 3).

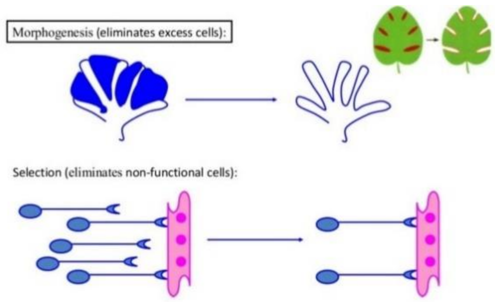

Fig. 3. Programmed leaf remodelling in morphogenesis processes and programmed elimination of non-functional cells in embryogenesis
Source: [14].

In the early stages of flower development in unisexual plants, the flower contains primordia for both male and female sexual organs. Subsequently, either the male or female organs are removed by programmed cell death. Abortion of stamens or carpels primordia is a type of programmed cell death that ensures the formation of unisexual flowers. In maize, for example, a monoecious plant, the male inflorescence is spatially separated from the female inflorescence. The young flowers in the panicle contain both the primordia of the stamens and the gynoecium, the latter stopping their development, due to the phenomenon of increased vacuolation of cells and loss of organettes.

Programmed cell death also occurs in the dehiscence of anthers, which ensures the release of pollen from pollen sacs. The dehiscence of the anther occurs by the degeneration of the tissue between the stoma and the connective tissue of the pollen sacs. Several cell types are involved in this process, being associated with increased activity of a cysteine protease [9]. In the tomato's anthers (Figure 4), along with the death of the group of cells under the stoma, there is also the degeneration of the protoplast of the epidermal cells adjacent to the stoma, endothecia and connective tissue [23].

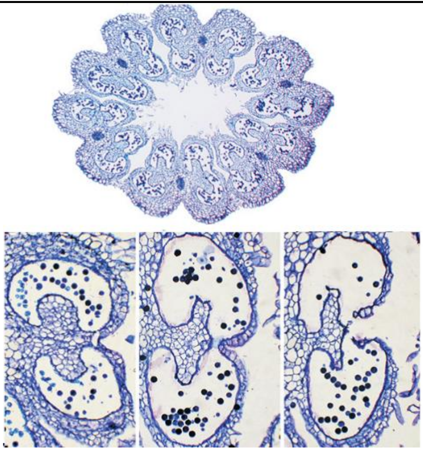

Fig. 4. Tomato anthers and a progressive loss of cell layers of the connective tissue
Source: [23].

Exposure of plants to various stressors such as hypoxia, water deficit, UV radiation, salinity, extreme temperatures, pollutants, toxins, heavy metals, etc., can induce oxidative stress and can be followed by cell death. Plants have developed mechanisms to counteract or tolerate adverse environmental conditions to a certain extent which, if exceeded, can lead to the death of a part of the plant or its death in its entirety. However, cell death in plants under conditions of abiotic stress can also be a regulated process, meant to ensure their survival. For example, the adaptation of plants to drought or intense lighting is often accompanied by the covering of their surface with a protective layer of dead single-celled hairs, which come from programmed cell death [11]. Any organism includes a series of polarizations and correlations. In plants, the genetic information responsible for form and function during ontogenesis creates a network of stresses in tissues, organs, cells, cytoplasm, chromosomes, etc. Tensions at various levels are interdependent, and an intervention in a certain point in organism can have a quantitative or qualitative consequence at another point, through the cell polarization phenomenon. Although there are obvious differences between animal and plant cells, some phenomena that accompany cell death in the cells of the two regna are similar, evidence of their descent from a common ancestor [9]. In plants, programmed cell death has specific features due to the cell wall, in particular. The uniqueness of some features of cell death in plants also results from the presence of other structures specific to the plant cell, such as chloroplasts and vacuole. In most situations of cell death in plants, the cell wall is preserved after degradation of the protoplast and reuse of its components. In the case of the hypersensitive response, cell death is accompanied by organ destruction, membrane collapse plasma and its separation from the cell wall [8]. The phenomenon of programmed cell death in plants is as important as cell division. This aspect of plant life is directly involved in the response to pathogens or stressors. The laws of in vitro cell variability are not fully known and therefore, many results are variable and even unpredictable. But future research in the field of biology and genetic engineering will certainly elucidate these unknowns.

CONCLUSIONS

Cell death is a complex phenomenon that accompanies plant growth and development from the time of seed germination to the maturation and senescence of plants. Exposure of plants to various stressors induces oxidative stress and may be followed by cell death. Genetic bioengineering and agricultural biotechnologies, through cell cultures, are a model system for studying programmed cell death in plants. In embryogenic phytovitrocultures, totipotent cells are divided asymmetrically and form pairs of cells, one of which develops into a somatic embryo, while the other involves the interruption of DNA synthesis and the occurrence of cell death. Programmed cell death plays an essential role in morphological modelling of the plant. The elucidation by researchers of all the phenomena specific to cell death in plants may bring in the future new arguments regarding the existence of unique mechanisms in the living world for the realization of certain processes and functions. Also, the deeper knowledge of the structure of matter and genetic processes in plants is the basis on which one can consciously act to direct these processes in order to modern plant improvement and obtain new genotypes with improved characteristics.

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EVOLUTION AND GLOBAL DISTRIBUTION OF GENETICALLY MODIFIED SOYBEAN AREA IN THE PERIOD 2014-2018

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Abstract

Currently, genetically modified (GM) crops are an important part of world agriculture, offering numerous benefits to farmers. This study investigates the dynamics of the cultivated area with GM crops, especially with genetically modified (GM) soybean, for the period 2014–2018, by country and by transgenic trait, using ISAAA and FAOSTAT databases. In the studied period, the top 5 GM crops countries were USA, Brazil, Argentina, Canada and India which totalled 166.1 million hectares or 89.5% of the global area. Regarding GM soybean, the top 5 countries were USA, Brazil, Argentina, Paraguay and Canada which cultivated 89.9 million hectares or 96.8% of the global area with this crop. The linear regression and the Pearson correlation coefficient have pointed out a general increasing trend for both cultivated areas. The USA and Brazil occupied the leading position in world with 32.93 and 32.55 million hectares of GM soybean, respectively. Herbicide tolerance (HT) has been consistently the dominant transgenic trait for GM soybean in USA, Argentina, Paraguay and Canada. In Brazil, the cultivated areas with stacked HT/IR traits have been larger than the areas cultivated with a single HT trait, in the last 3 years. As a conclusion, the global area of GM soybean will continue to increase due to its important economic role in the agriculture development and environmental benefits.

Key words**:** *GM crops, GM soybean, herbicide tolerance, insect resistance, trend*

INTRODUCTION

1996 was the first year in which a significant area of GM crops of 1.66 million ha was cultivated (in 6 countries). Since then there has been a continuous increase in plantings, and in 2018, the global area reached 191.7 million ha (in 29 countries). Almost all of the global GM crops area comes from soybean, maize, cotton and canola [11].

Genetically modified organisms can be defined as organisms in which the genetic material (DNA) has been altered by recombinant DNA technology (combining genes from different organisms) [2].

Genetic engineering has made it possible to significantly improve crops through transgenesis (genetic modification), but nevertheless, the discussions between communities for and against this technology have failed to move forward. Those who support this technology believe that increasing production and reducing costs are ultimately beneficial to consumers. On the other hand, those who are against this technology are concerned about the risks to the environment and health [1].

Soybean (*Glycine max* (L.) Merr.), called the "king of beans" is one of the most important sources of protein, being used as a raw material to obtain many edible and inedible products, such as cooking oil, milk, vegan food, feed and biodiesel [18].

The results obtained by various authors showed that the full fat soybean used as feed can ensure high performances in broilers fattening under lower costs and a high meat and fat quality [16].

Due to the worldwide economic importance of soybean, this crop has become a target for genetic improvement.

Soybean have a very limited tolerance to many of the herbicides used, hence, to produce herbicide-tolerant soybean by conventional breeding, genes for resistance that must be available in crossing material that is compatible with soybean are needed. A lack of sufficient variability in resistance levels of its germplasm has hindered breeding efforts [7].

Genetic transformation of plants has provided an attractive genetic improvement for soybean, allowing the obtaining of new and genetically diverse plant materials [8].

Genetically modified (GM) (transgenic or biotech crops) are cultivated mainly in developing countries by millions of farmers. According to [15], they provide economic benefits to farmers by increasing yields by 22% and farm profit by 68%, but also environmental benefits by reducing the use of chemicals by 37%. Also, genetic modified foods have the potential to solve problems related with malnutrition, under nutrition and environment protection [3].

In this context, the paper aimed to analyze the global trend of the area cultivated with GM soybean in the period 2014-2018, in order to determine the top 5 producing countries and what is the proportion of adoption of HT and HT/IR traits in these countries. Finally, the most approved events for GM soybeans used in food, feed processing and in cultivation were presented.

MATERIALS AND METHODS

This study is based on International Service for the Acquisition of Agri-biotech Applications (ISAAA) and Food and Agriculture Organization of the United Nations (FAOSTAT) data collected for the period 2014-2018.

The main methods used in this study were the following: linear regression, Pearson correlation coefficient (r), coefficient of determination (R^2), average, standard deviation and coefficient of variation. The data were statistically processed using Microsoft Excel.

The results were presented in Tables and illustrated in Graphics.

RESULTS AND DISCUSSIONS

Evolution and global distribution of genetically modified (GM) crops area

The global area used for transgenic crops increased from 181.5 million hectares in 2014 to 191.7 million hectares in 2018 (+10.2 million hectares in the studied period. The total worldwide variation was slight (CV=2.79%). The general trend reflects a continuous increasing, except for 2015 when there was a fluctuation. The highest growth of GM crops area was registered in the year 2016 when the area increased by 3.0% compared to the level of 2015. In 2017 versus 2016, the area increased by 2.5%. The last year registered slight increases (+1.0%) versus 2017. The year with a slight decline was 2015, when GM crops area decreased by ~ 1.0% compared to the previous year (Figure 1).

The intensity of the linear relationship expressed by Pearson correlation coefficient (r=0.934) indicates a strong positive relationship of a linear nature between the global area used for cultivating GM crops and the year of cultivation. The coefficient of determination (R^2=0.871) explains that 87.1% of the variation in global area with GM crops is caused by the year of cultivation (Figure 1).

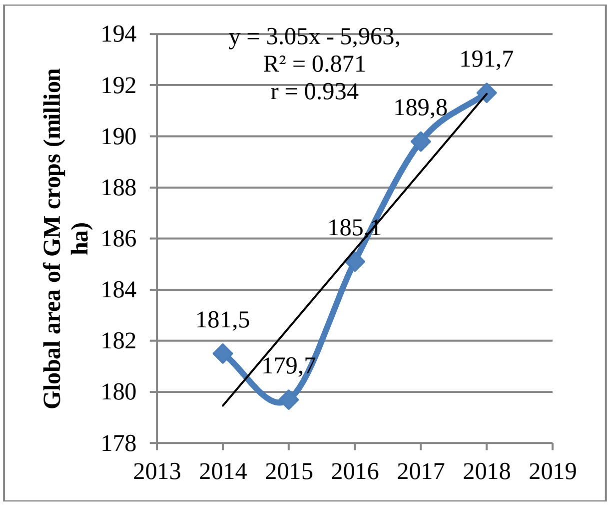

Fig. 1. Evolution of hectares (million ha) cultivated with GM crops in world, 2014-2018

Source: Own design and processing based on the data [9, 10, 11, 13, 14]

In the studied period, the top 5 biotech crops countries were USA, Brazil, Argentina, Canada and India which totalled 166.1 million hectares or 89.5% of the world's GM crops acreage (Table 1).

The data summarized in Figure 2, reflect the fact that the area cultivated with GM crops increased from 2014 to 2018 in USA, Brazil and Canada.

A higher increase over the study period was observed for Brazil where the cultivated area increased by 21.5% (9.1 million hectares) in 2018 compared to 2014. In Argentina, a decrease in cultivated areas was observed in 2016, 2017 and 2018 compared to 2015 and 2014. In India, the area of 11.6 million hectares remained relatively constant from almost every year, with fluctuations in 2016 and 2017 (Figure 2).

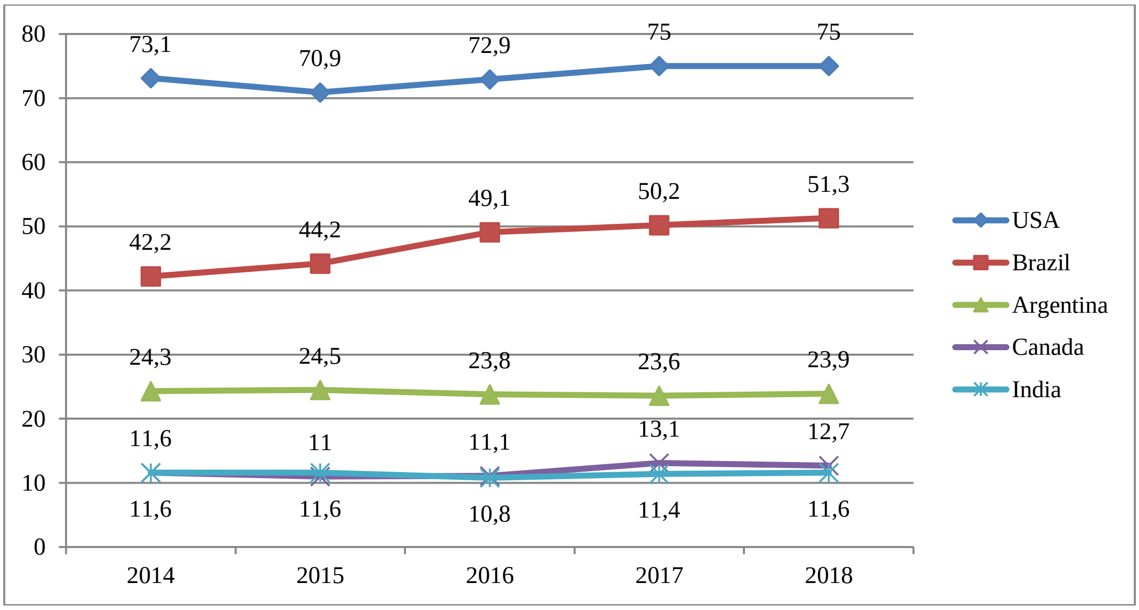

Fig. 2. Evolution of the GM crops areas in top 5 biotech crops countries (million hectares), 2014-2018
Source: Own design and processing based on the data [9, 10, 11, 13, 14]

The values of the Pearson correlation coefficients presented in Table 1 confirm the intensity of the relations between the global area and the area allocated to genetically modified crops in each of the top 5 biotech countries, during the studied period.

Table 1. Statistics values calculated for areas (million ha) with GM crops in top 5 biotech crops countries (2014-2018)

Country	Average	St. dev.	Variation coefficient (%)	Pearson correlation coefficient
USA	73.4	1.7	2.3	0.730
Brazil	47.4	4.0	8.4	0.962
Argentina	24.0	0.4	1.7	-0.726
Canada	11.9	1.0	8.4	0.715
India	11.4	0.3	2.6	-0.091
Total GM crops in top 5 countries	166.1	7.4	4.4	
Global GM crops	185.6	5.2	2.8	

Source: Calculated by author based on the data from [9, 10, 11, 13,14].

Globally, the largest area of genetically modified crops was registered in the USA where, on average, 73.4 million hectares (39.5% of the global area) were cultivated. Brazil occupied the second position globally, the cultivated area being 47.4 million hectares (25.5% of the global area). Argentina was the third largest producer of GM crops, registering 24 million hectares (12.9% of global area), Canada was the fourth largest producing country with 11.9 million hectares (6.4%) and India was fifth largest producing country with 11.4 million hectares (6.1%) (Table 1).

The variation coefficient for the area with GM crops in each country is shown in Table 1. The values of this coefficient were less than 10% showing that the cultivated area did not varied too much and remained relatively homogeneous over years.

Evolution and global distribution of genetically modified (GM) soybean area

The global area with GM soybean had, in general, a continuous increasing from 90.7 million hectares in the year 2014 to 95.9 million hectares in the year 2018 (+5.7%). A highest hectare of GM soybean was registered in the year 2017 when area increased by 2.9% compared to the level of 2016. Also, in 2015 versus 2014, the area increased by 1.5%. The last year registered a slight increase (+1.9%) versus 2017. The year with a slight decline was 2016 when area decreased by 0.8%

compared to the previous year. The value of Pearson correlation coefficient (r=0.920) indicated a strong positive relationship of a linear nature between the global area used for planting GM soybean and the year of cultivation. The coefficient of determination (R^2=0.847) explains that 84.7% of the variation in global area with GM soybean is caused by the year of cultivation (Figure 3).

Therefore, an increase in the global area allocated to GM crops was confirmed, and the global area with GM soybean shows a similar increasing trend in the number of hectares cultivated.

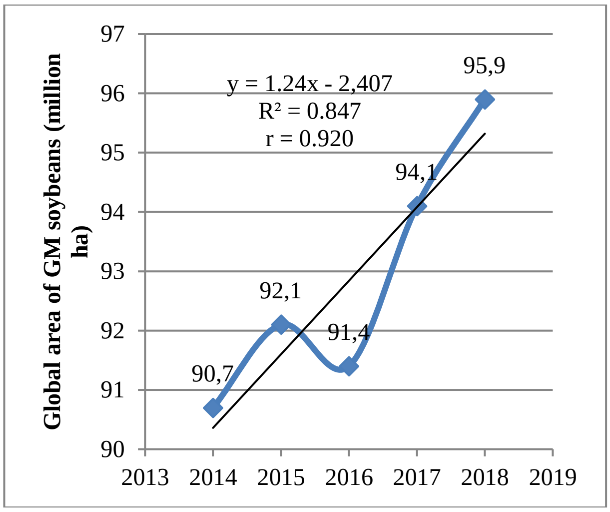

Fig. 3. Evolution of hectares (million ha) cultivated with GM soybean in world (2014-2018)
Source: Own design and processing based on the data [9, 10, 11, 13, 14].

For the studied period, the top 5 countries that cultivated the largest areas of GM soybean were the USA (32.93 million hectares), Brazil (32.12 million hectares), Argentina (19.34 million hectares) Paraguay (3.19 million hectares) and Canada (2.28 million hectares) (Table 2).

During the studied period, India did not grow GM soybean, but only GM cotton and GM mustard, so we excluded it from the top 5 countries.

The global area with GM soybean of 92.84 million hectares was comprised especially in these top 5 countries, which totalled 89.86 million hectares or 96.8% of the global area cultivated with GM soybean, and 73.6% of the global area with soybean crop (Table 2).

The area with GM soybean in the USA had an increasing trend, but in certain years there have some fluctuations. A higher increase trend was observed for Brazil where the area cultivated increased from 29.07 million hectares in 2014 to 34.86 million hectares in 2018 (+19.9%). In Argentina, area registered a decline in the last 3 years (2016, 2017 and 2018) versus 2015 and 2014. The general trend for Paraguay remained relatively stable, reflecting a continuous decline, but in 2018 it registered a slight increase. In Canada, the area of GM soybean increased continuously from 2.1 million hectares in 2014 to 2.5 million hectares in 2017, and decreased in 2018 versus 2017 (Figure 4).

Table 2. Statistics values calculated for areas (million ha) with GM soybean in top 5 countries (2014-2018)

Country	Average	St. dev.	Variation coefficient (%)	Pearson's correlation coefficient
USA	32.93	1.06	3.22	0.783
Brazil	32.12	2.39	7.45	0.989
Argentina	19.34	1.50	7.76	-0.908
Paraguay	3.19	0.29	9.09	-0.393
Canada	2.28	0.17	7.46	0.877
Total GM soybean in top 5 biotech countries	89.86			
Global GM soybean	92.84			
Global soybean crop	122.1			

Source: Own calculation based on the data [5, 9, 10, 11, 13, 14].

According to [11], the reduction in the area of GM soybeans in 2018 compared to 2017 and 2016 in Argentina and reduction in 2018 compared to 2017 in Canada was due to drought in these countries and low soybean prices, especially in Canada.

The intensity of the linear correlation between year of cultivation and area allocated to GM soybean in each of top 5 countries was confirmed by the values of Pearson correlation coefficients. The coefficients of variation were small (<10%) in each country, reflecting the fact that there are no large discrepancies over years (Table 2).

In European Union, including in Romania, only one GM crop event is authorized for cultivation, i.e. maize MON810, although its cultivation is prohibited in a number of EU

countries and territories by Commission implementing decision 2016/321 [19].
Although only one maize event is authorized for cultivation in the EU, over 50 events from various genetically modified crops are authorized for import and use as food and feed. As GM soybean is not cultivation, it is estimated that the EU will import about 30 million tonnes of GM soybean annually [17].

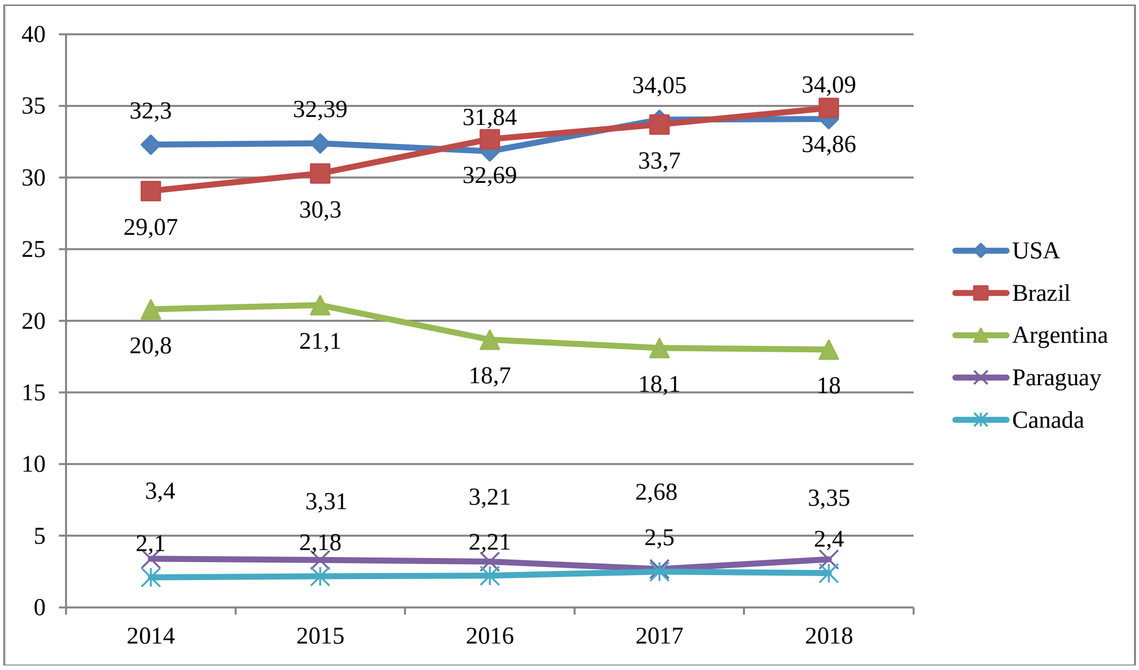

Fig. 4. Evolution of the GM soybean areas in top 5 countries (million hectares), 2014-2018
Source: Own design and processing based on the data [9, 10, 11, 13, 14]

Evolution and global distribution of transgenic traits in the area of GM soybean

Herbicide-tolerant (HT) crops were developed to survive the application of some effective herbicides (such as glyphosate, glufosinate, dicamba etc.) [4]. Insect-resistant (IR) crops contain a gene from the soil bacterium *Bacillus thuringiensis (Bt)* that produces a protein toxic to specific insects, protecting the plant over its entire life [6]. During the studied period, herbicide tolerance trait (sometimes associated with another) was consistently the dominant trait of GM soybean cultivated in USA, Argentina, Paraguay and Canada. In average, the GM soybean cultivated in the USA and Canada on 32.9 and 2.2 million hectares, respectively, was 97-100% herbicide-tolerant (Table 3).

Table 3. Evolution and distribution of GM soybean area by traits in top 5 countries (2014-2018)

Country	By trait	Area (million ha)					% transgenic trait				
		2014	2015	2016	2017	2018	2014	2015	2016	2017	2018
USA	HT	32.3	32.4	31.8	34.0	34.1	100	100	100	100	100
	Stacked HT/IR	0	0	0	0	0	-	-	-	-	-
Brazil	HT	23.9	18.5	12.4	13.6	14.6	82.2	61.0	37.9	40.3	41.9
	Stacked HT/IR	5.2	11.9	20.3	20.1	20.2	17.9	39.3	62.1	59.6	57.9
Argentina	HT	20.8	20.4	16.2	15.0	13.7	100	96.7	86.7	82.9	76.1
	Stacked HT/IR	0	0.7	2.5	3.1	4.3	-	3.3	13.3	17.1	23.9
Paraguay	HT	3.3	3.2	2.7	1.7	1.7	97.0	96.7	84.3	63.1	50.0
	Stacked HT/IR	0.1	0.1	0.5	1.0	1.7	3.0	3.3	15.7	3.9	50.0
Canada	HT	2.1	2.0	2.1	2.5	2.4	100	91.7	95.0	100	100
	Stacked HT/IR	0	0	0	0	0	-	-	-	-	-

HT: herbicide tolerance; IR: insect resistance
Source: Own processing based on the data [9, 10, 11, 13, 14].

Brazil, Argentina and Paraguay cultivated GM soybean with a single HT trait on 16.6, 17.2 and 2.5 million hectares, respectively and with the stacked HT/IR traits (combined of herbicide tolerance and insect resistance) on 15.5, 2.1 and 0.7 million hectares, respectively. In these countries was observed a declining in HT trait over the years, with the increasing the proportional of the stacked HT/IR traits, but in Brazil, the cultivated areas with stacked HT/IR traits have been larger than the cultivated areas with HT trait, in the last 3 years (Table 3). According to [11], stacked HT/IR traits products are preferred by many farmers due to their cost-saving technology, especially the Intacta™ soybean. The variation coefficients for transgenic traits were high and very high in Brazil, Argentina and Paraguay, reflecting that there are discrepancies during the analyzed period (Table 4).

Table 4. Statistics values calculated for traits of GM soybean cultivated (million ha) in top 5 countries (2014-2018)

Country	HT			Stacked HT/IR		
	Average	St. dev.	Variation coefficient (%)	Average	St. dev.	Variation coefficient (%)
USA	32.9	1.1	3.2	0	-	-
Brazil	16.6	4.7	28.3	15.5	6.8	43.9
Argentina	17.2	3.2	18.6	2.1	1.8	85.7
Paraguay	2.5	0.8	32.0	0.7	0.7	100.0
Canada	2.2	0.2	9.09	0	-	-
Total GM traits soybean in top 5 countries	71.4			17.2		

HT: herbicide tolerance; IR: insect resistance
Source: Own calculation based on the data [9, 10, 11, 13, 14].

Status of some GM soybean approved events used in food, feed processing and in cultivation in world

Since 1996, when GM crops events began to be marketed, the number of approvals has varied from year to year.

In 2018, approvals were issued for genetically modified crops in 70 countries. These authorizations were intended to regulate genetically modified crops used for cultivation, food and feed. Among the GM soybean events, herbicide-tolerant soybean (HT) with the name GTS 40-3-2 received 57 approvals (in EU 28 + 28 countries), herbicide-tolerant soybean with the name MON89788 received 45 approvals (in EU 28 + 25 countries) and herbicide-tolerant soybean with the name A2704-12 also received 45 approvals (in EU 28 + 24 countries) [11].

Tables 5, 6 and 7 present the top 3 soybean approval events, by country and by type of approval.

Approvals are granted for food, feed and cultivation on a per event basis according to the regulations of each country.

It is possible, then for an event of GM crop to receive 3 different approvals per each country (food, feed and cultivation), 2 approvals (food and feed) or only one approval.

Thus, the GTS 40-3-2 event has approvals for food, feed and cultivation in Argentina, Bolivia, Brazil, Canada, Japan, Paraguay, USA and Uruguay, but has approvals for cultivation only in Chile, Costa Rica and South Africa.

The MON89788 event has approvals for food, feed and cultivation in Canada, Japan and USA, but has approvals for cultivation only in Costa Rica, Mexico and Uruguay.

The A2704-12 event has approvals for food, feed and cultivation in Argentina, Brazil, Canada, Japan and USA, but has approvals for cultivation only in Uruguay.

Table 5. Herbicide-tolerant soybean GTS 40-3-2 event

Trade name/ Developer	Method of trait introduction	Commercial trait	Authorizations			
			Country	Food	Feed	Cultivations
Roundup Ready™ soybean/ Monsanto Company (including fully and partly owned companies)	Microparticle bombardment of plant cells or tissue	Herbicide tolerance	Argentina	x	x	x
			Australia	x		
			Bolivia	x	x	x
			Brazil	x	x	x
			Canada	x	x	x
			Chile			x
			China	x	x	
			Colombia	x	x	
			Costa Rica			x
			European Union	x	x	
			Indonesia	x		
			Iran	x		
			Japan	x	x	x
			Malaysia	x	x	
			Mexico	x		x
			New Zeeland	x		
			Nigeria	x	x	
			Paraguay	x	x	x
			Philippines	x	x	
			Russia	x	x	
			Singapore	x	x	
			South Africa			x
			South Korea	x	x	
			Switzerland	x	x	
			Taiwan	x		
			Turkey		x	
			United States	x	x	x
			Uruguay	x	x	x
			Vietnam	x	x	

Source: Own processing based on the data [12].

Table 6. Herbicide-tolerant soybean MON89788 event

Trade name/ Developer	Method of trait introduction	Commercial trait	Authorizations			
			Country	Food	Feed	Cultivations
Genuity® Roundup Ready 2 Yield™ Monsanto Company (including fully and partly owned companies)	*Agrobacterium tumefaciens* - mediated plant transformation	Glyphosate herbicide tolerance	Argentina	x	x	
			Australia	x		
			Canada	x	x	x
			China	x	x	
			Colombia	x	x	
			Costa Rica			x
			European Union	x	x	
			India	x	x	
			Indonesia	x		
			Iran	x		
			Japan	x	x	x
			Malaysia	x	x	
			Mexico	x		x
			New Zeeland	x		
			Nigeria	x	x	
			Philippines	x	x	
			Russia	x	x	
			Singapore	x	x	
			South Africa	x	x	
			South Korea	x	x	
			Switzerland	x	x	
			Taiwan	x		
			Thailand	x		
			Turkey		x	
			United States	x	x	x
			Uruguay			x
			Vietnam	x	x	

Source: Own processing based on the data [12]

Table 7. Herbicide-tolerant soybean A2704-12 event

Trade name/ Developer	Method of trait introduction	Commercial trait	Authorizations			
			Country	Food	Feed	Cultivations
Liberty Link® soybean/ BASF	Microparticle bombardment of plant cells or tissue	Herbicide tolerance	Argentina	x	x	x
			Australia	x		
			Brazil	x	x	x
			Canada	x	x	x
			China	x	x	
			Colombia		x	
			European Union	x	x	
			India	x	x	
			Iran	x		
			Japan	x	x	x
			Malaysia	x	x	
			Mexico	x		
			New Zeeland	x		
			Nigeria		x	
			Philippines	x	x	
			Russia	x	x	
			Singapore	x	x	
			South Africa	x	x	
			South Korea	x	x	
			Taiwan	x		
			Turkey		x	
			United States	x	x	x
			Uruguay			x
			Vietnam	x	x	

Source: Own processing based on the data [12].

CONCLUSIONS

In the studied period, the cultivated areas with GM crops, including GM soybean, generally showed an increasing trend.

The top 5 GM crops countries were USA, Brazil, Argentina, Canada and India, but the top 5 GM soybean countries were USA, Brazil, Argentina, Paraguay and Canada.

The USA and Brazil occupied the leading position in world with 32.93 and 32.55 million hectares cultivated with GM soybean, respectively.

Herbicide tolerance (HT) has been consistently the dominant transgenic trait for GM soybean in USA, Argentina, Paraguay and Canada. In Brazil, the cultivated areas with stacked HT/IR traits have been larger than the areas cultivated with a single HT trait in the last 3 years.

In 2018, the herbicide-tolerant soybean events with the name GTS 40-3-2, MON89788 and A2704-12 have the most numerous approvals in world.

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METHODOLOGY FOR ASSESSING THE COMPETITIVENESS OF AGRICULTURAL ENTERPRISES

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Abstract

The purpose of this article is to develop and validate a methodology for analyzing and assessing the competitiveness of agricultural enterprises. The process of establishing a methodology for analyzing and assessing the competitiveness of agricultural enterprises covers two main stages – (1) identification of indicators for analyzing and assessing the competitiveness of agricultural enterprises and (2) validation of indicators for assessing the competitiveness of agricultural enterprises. The main methods used for designing the methodology are the multi-criteria analysis method and the expert assessment method. The markers for diagnostics of competitiveness of the agricultural enterprise are - competitiveness of the products produced by it; degree of adaptability towards the changing environment; price leadership and product differentiation; availability of innovation activity, degree of concentration of capital in the business model, etc.

Key words: *competitiveness, competitive advantage, agricultural enterprise, innovation, efficiency*

INTRODUCTION

Competitive ability is a phenomenon that exists in every ecosystem as a core ability for survive. It is characteristics of all living organisms, a property that determines the biological feature to survive in dynamic and chaotic environment. There is a wide dispute across researchers about the origin of competitiveness of enterprise. Some part of research community [29], [6], [19], [15], [16], [10], [14] and [17] declare that competitiveness of the enterprise should be linked with the *competitive ability of products and services provided by the entity*.

According to [28], "products are competitive when their quality is higher at minimum production costs compared to the competitors" [2]. "Product quality" means "the set of properties that determine the suitability of a given product to satisfy certain needs in accordance with its purpose" [9]. The interplay between the product quality and the level of competitive ability of the enterprise and its business processes is essential. The main barrier in defining the competitiveness of provided goods and services by agricultural enterprise is that the quality is a strictly subjective perspective of consumer as such there is still no reliable tool for its measurement. The subjective aspect of the product quality derives from the fact that when byers consuming the product, they attached to it different level of importance and measure in a different way the utility that they obtained. This specific character of product quality sets obstacles for quantitative assessment of quality and competitive ability of product as second order effect.

According to Pride, the main role „in assessing the competitiveness of products should be played by the consumer" [23]. It is the consumer who measure the success of the efforts made by marketing managers of the company to react to the market conditions. The main weaknesses of the idea that product quality determines its ability to compete on the market is directed towards the fact that quality management use standards that guarantee the quality of provided good and services. These standards are used as tools for evaluation of deviations in business processes in agricultural enterprise, i.e. they play role of controllers in the production and marketing processes. By taking quality management as fundamental factor for achieving competitive ability of enterprise, managers may remain blind to changes in market conditions and may focus only on internal environment and its control [17].

Some researchers [4], [20], [31], [2], [22] associate the competitive ability of enterprise with *the efficiency of resources* used in production process. Other part of research community such as 21], [7], [30], [33], [3], [5] link the competitive ability of enterprise with *the degree of adaptability to the changes in business conditions*. According to [4], [24], [25] the competitiveness of an enterprise can be assessed by its *profitability* (return on assets and equity). Other researchers such as [14], [12], [34] and [1] declare that competitive ability of enterprise is in close relationship with the size of the *market share.* According to them the market share is a reliable marker of competitive ability of company as a whole. The market share as e competitive factor is depending on the management of two business processes: *price leadership and product differentiation.*

Price leadership is an ability of entity to produce goods and services at a lower production costs compared to the main competitors. According to [18], [28] the main source of this competitive factor is the ability of company to realize economies of scale. Economies of scale is a prerogative concerning the ability of managers to reduce and production costs on level that main competitors could not reach. By providing these conditions the economies of scale play a major role in strategic planning of product price. Establishment of economies of scale can lead to offer the cheapest product to the market segment. The other important component of good market leadership expressed by the size of market share is the ability to introduce an adequate product differentiation. This is the marketing image built in costumers that by consuming the offered goods and/or services of company they receive additional benefit that no one competitor is offering at the moment in certain market segment. With the product differentiation the company aim to establish a loyal demand across the consumers. According to [32], [34], the competitive ability of the enterprise is based on the availability of *innovations* and process that provide them. Other researchers, such as [35], declare that the lack of innovations or the low level of adoption of innovations by the company will reduce its competitive ability in long-term period. According to [13], [11], [5] the innovations are a key factor for increasing the competitive ability of the company. The aim of adoption of these innovations is to achieve a higher efficiency of resources involved in production process and to reduce the level of production costs. The competitive ability of enterprise also depends on whish part of the *value chain it is located.* Some researchers such as [11], [27], link the competitive ability of enterprise with the *exploitation of value generated along the value chain*.

In most of the cases, the enterprises that create new value (innovation) fail to "retain" it and exploit it for long-term profit in the industry. In addition, it should be noted that a cmpany is competitive when it generates and/or exploits an already developed value chain so that its market share grows steadily over time.

According to [25] and [9] conditionally speaking, there are two types of actors in the value chain. The first ones are those who generate new value along the chain or create a new value chain (inventors). The other ones are those who focus their efforts on the exploitation of the created value (exploiters). The network of values thus established creates conditions for both competition and cooperation between these two types of actors. That often results in establishing strategic alliances between those generating the value and those exploiting it, and these alliances aim at the benefit of all participants. It is clear from all that has been said so far that competitiveness depends, above all, on the relationship between the enterprises in the value chain.

MATERIALS AND METHODS

When defining the competitive ability of the agricultural enterprise, it is necessary to take into account its special features. The specificities determine the different approaches to achieving competitive ability in the sector [5]. All characteristics inherent to competitive ability, at enterprise and sector level, are achieved by realizing the competitive advantages of the entities in the industries. Therefore, when analysing the competitive ability of the agricultural enterprise, the impact of the processes of *specialization*, *concentration* and *integration* of the branches in the sector must be taken into account. As a result of these processes specific cross-sectoral links are formed and they are the basis for sustainable development and competitiveness of enterprises and the sector.

The purpose of this article is to develop and validate a methodology for analysing and assessing the competitiveness of agricultural enterprises.

RESULTS AND DISCUSSIONS

The design of methodology is based on two main fundaments – (1) identification of factor for analysing and assessing the competitive ability of agricultural enterprises and (2) validation of those factors as assessing tools. Multi-criteria analysis and the expert assessment method are used as a toolkit for assessment of level of competitiveness.

Identification and validation of drivers, markers and indicators for assessing the competitiveness of agricultural enterprises.

The identification and validation of drivers, markers and indicators - hereinafter referred to as “indicators” - for assessing the competitiveness is carried out through multi-criteria analysis. There is a potential list of indicators evaluated by experts from different scientific and practical fields – economists, technologists, agronomists, managers and marketers. Based on their assessments, the final set of indicators is formed and they are used to assess the competitiveness of agricultural enterprises and the sector as a whole. The methodology is divided into different steps, comprising literature review, multi-criteria assessment, selection of indicators, integration of indicators, field research, data analysis and assessment of applicability. As a result of an extensive literature review, a list of indicators that take various aspects of competitiveness into account is drawn up. A special place among them is occupied by:

-Indicators used by national and international institutions;

-Specific indicators (used in the scientific literature);

-Indicators created by the authors of the methodology presented.

Table 1. Description of the expert assessment criteria of the proposed list of indicators for assessment of the competitiveness of agricultural enterprises

Criteria for expert selection		**Description**
1 & 2	Distinctive power by (1) time/(2) place	The ability to reflect by (1) time/(2) place the differences due to external factors and to factors resulting from the management
3	Analytical value	The indicator should be scientifically valid, i.e. to be calculated by means of established scientific terms
4	Measurability	The indicator should be easy to measure.
5	Transparency	The meaning of the indicator should be clear to understand as well as unambiguous.
6	Appropriateness	The indicator should help to take into account the effect of the management of competitive factors
7	Transferability	It should be possible for the indicator to be used in different types of business structures
8	Relevance	The indicator should be as relevant as possible in terms of competitiveness relevant to the database

Source: adapted model after Borisov et al (2013) [3].

In Multi-Criteria Expert Assessment (MCA), the validation of potential indicators is carried out by experts. They are selected based on their competence and commitment to solving problems related to competitiveness in the agricultural sector. The indicators and experts are grouped thematically into panels that form the different aspects of competitiveness. The assessment of potential indicators by the experts is carried out according to eight principles included in the criteria of expert selection (CES) – Table 1.

After having agreed to participate, the experts receive the following documents: a list of characteristics of indicators (name, assessment sustainability, description, source, calculation method, information needed, assessment and interpretation scale) and guidance with regard to the assessment procedure. Based on these documents, the experts, according to their thematic affiliation, assess each indicator in terms of these eight principles (Table 1). The experts use a 4-point rating scale for assessing an indicator in terms of relevance with each of the 8 principles as follows: 0 – not relevant, 1 – low degree of relevance, 2 – a strong degree of relevance and 3 – a very strong degree of relevance.

Reporting is done according to a scale where the indicators with a score above a given threshold are being selected. The indicator selection criterion includes the score received by the expert for each indicator and the average score on the eight principles. The different expert scores on each indicator are synthesized into an "arithmetic mean" formed as an expert consensus score equal to the weighted average score obtained from the sum of all experts' scores on a given indicator. The selected indicators are included in a questionnaire to be used in a test survey in selected agricultural enterprises.

Validation of the indicators for analysis of the competitiveness of agricultural enterprises

The indicators used for the assessment and diagnosis of competitive ability of agricultural enterprises are validated by application of multi-criteria analysis and expert assessment method. These include the drivers, markers and indicators for assessing the competitive ability. A group of 33 experts took part in the indicator validation process and they validated the compliance of the indicators with the principles set out in the methodological part.

Figure 1 shows the expert assessment of the drivers used for diagnostics of enterprise competitiveness.

The individual scores of each individual driver are synthesized into an "arithmetic mean" formed as an expert consensus score (ECS) equal to the weighted average score obtained from the sum of all experts' scores for a given driver. The drivers that have received an ECS score above 2.5 are defined as reliable with regard to the underlying principles in the validation of indicators (see the figure, green bars).

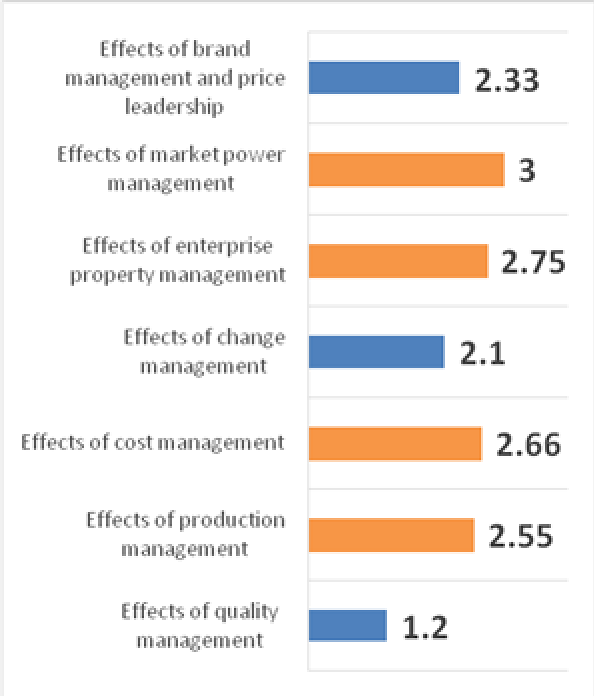

Fig. 1. Expert assessment of the validity of the drivers for competitiveness of agricultural enterprises.
Source: own research, 33 experts were included in it, 2020.

The drivers indicated as reliable by the experts are the effects of: (1) market power management - the indicator score is 3.00; (2) the enterprise property management (with indicator score - 2.75); (3) cost management – the indicator score is 2.66 and (4) production management – the indicator score is 2.55.

Figure 2 shows the summarized expert assessment of the reliability of the markers for the competitive ability of agricultural enterprises. Of all 22 markers, 11 markers have been validated as reliable by the experts.

The experts declare the that markers with high reliability for diagnostics of agricultural enterprises are the following: (1) market share - with a score of 3.00; (2) profit and return - with a score of 3.00; (3) the competitive advantages - with a score of 3.00; (4) the brand with a score of 3.00; (5) loyal demand with a score of 3.00; (6) the offer of unique value - score 2.8; (7) participation in strategic alliances in the value chain - score 2.65; (8)

the efficiency of the resources used - score 2.55; (9) the availability of new business models - score 2.55, and the liquidity of the enterprise - score 2.55.

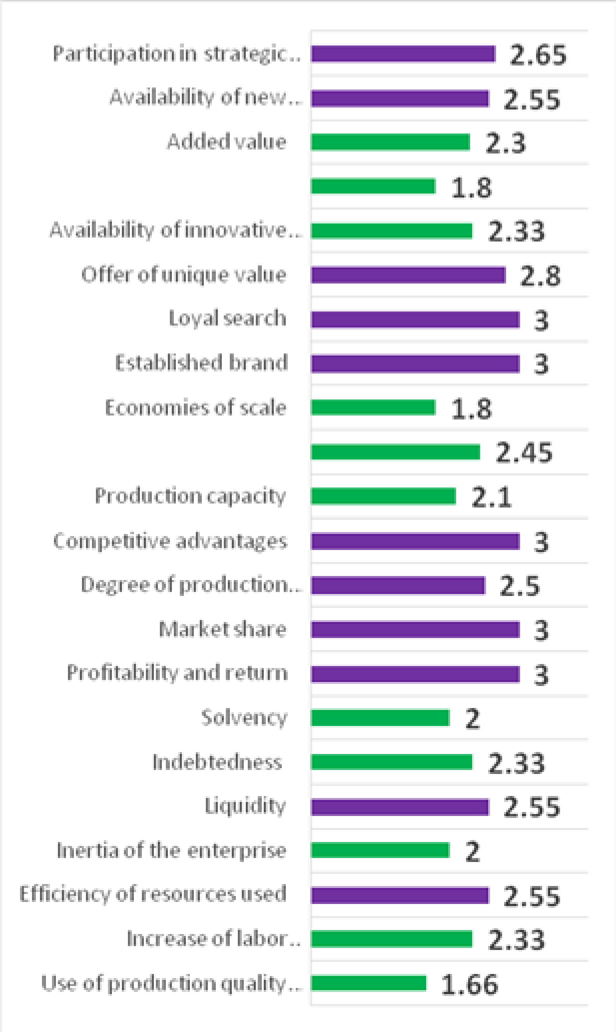

Fig. 2. Expert assessment of the validity of the markers for competitiveness of agricultural enterprises.
Source: own research, 33 experts were included in it, 2020.

The next element of the analytical apparatus for analysis and assessment of competitiveness, subject to validation, are the assessment indicators at agricultural enterprise level.

Considering the presented 30 indicators, the experts have validated that 13 of them (the indicators with an ECS score above 2.5) can be used with high reliability in the study (Figure 3).

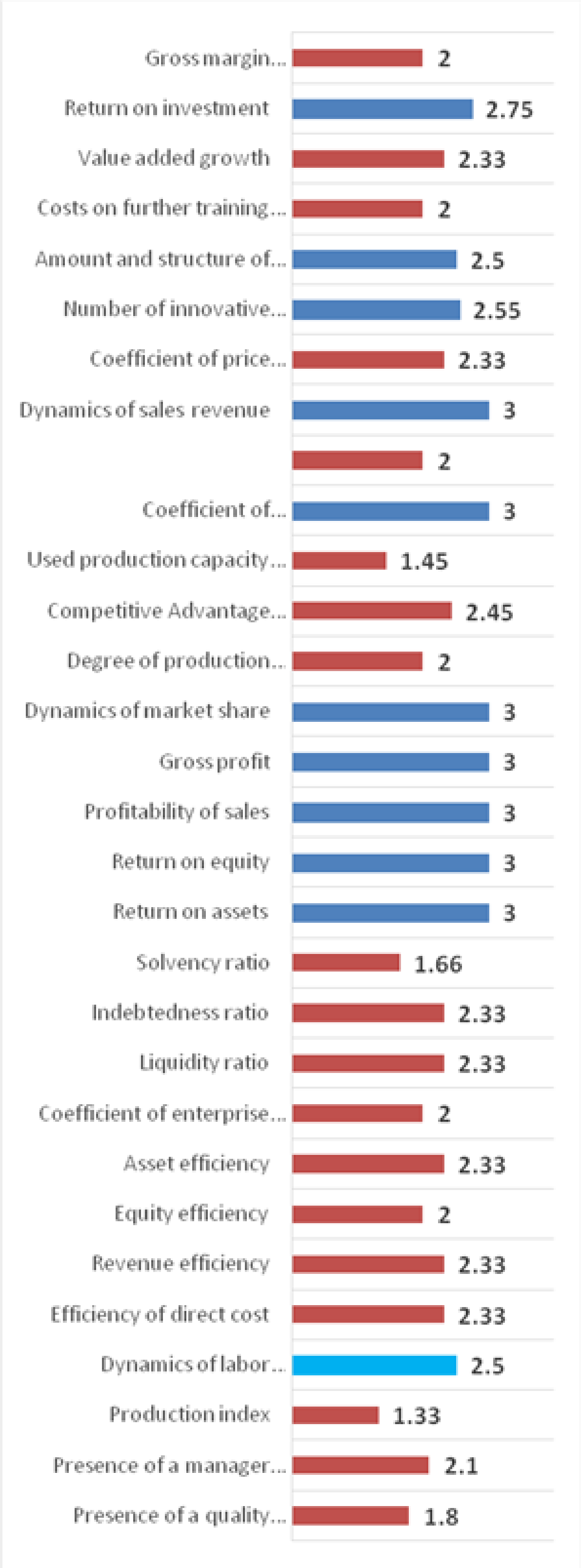

Fig. 3. Expert assessment of the validity of the markers for competitiveness of agricultural enterprises.
Source: own research, 33 experts were included in it, 2020.

In Figure 3, the blue bars reflects: (1) dynamics of market share; (2) gross profit; (3) profitability of sales; (4) return on equity - the (5) return on assets; (6) coefficient of competitiveness; (7) dynamics of sales revenue; (8) return on investment; (9) number of innovative products; (10) debt ratio; (11) liquidity ratio; (12) amount and structure of research and development costs and (13) labour productivity in the enterprise.

CONCLUSIONS

It can be outlined that in the theory of competitiveness, the management of competitive ability is perceived as science, art, skill and ability to defeat the main competitor by using one's own and/or competitor's competitive advantages while taking into account the market environment.

Competitive ability can and should be taken into account by knowing its intrinsic characteristics. There are specific factors that comply with these characteristics. Some of the factors can be used to determine the level of competitiveness (when measuring it) that the agricultural enterprise has achieved. The indicators in this study are markers of competitiveness. Another part of the indicators can be used to reveal the reasons for the achievement of a certain level of competitiveness by the agricultural enterprise. In the present study these indicators play the role of drivers of competitiveness. The limit for grouping the indicators in a group of markers or a group of drivers is conditional and is determined by the objectives of the study.

The markers for diagnostics of competitiveness of the agricultural enterprise are - *competitiveness of the products produced by it; degree of adaptability towards the changing environment; price leadership and product differentiation; availability of innovation activity, degree of concentration of capital in the business model, etc.*

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COMPARATIVE STUDY ON THE DYNAMICS OF SURFACES CULTIVATED IN CONVENTIONAL AND ORGANIC SYSTEM, IN CROPS OF WHEAT, CORN, BARLEY AND SUNFLOWER

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Abstract

Agriculture is the economic sector that benefited most from Romania's entry into the European Union, especially through the National Rural Development Program - PNDR 2014-2020 program, which was based on providing non-reimbursable funds to Romanian farmers in order to modernize and expand agricultural holdings. In total, since Romania's accession to the EU, the Ministry of Agriculture and Rural Development, has developed European and national funds for agriculture of over 26 billion euros, the average annual absorption rate being 96%. The paper presents the dynamics of cultivated areas, in a crop formed by wheat, barley, corn and sunflower crops, in the period 2015-2020, cultivated in an organic system compared to the conventional one. Because crop rotations play a key role in ensuring the sustainability of modern farming systems, they remain crucial in the practice of organic farming systems, as they combat diseases, pests, weeds, water shortages and soil nutrients.

Key words: *culture systems, organic farming, conventional agriculture, cultivated areas*

INTRODUCTION

In 2019, Romania ranked first in the EU in corn and sunflower production and fourth in wheat, after France, Germany and Poland.

Agriculture is a strategic sector of the Romanian economy. It has a share of 5.2% of the Gross Domestic Product and 23% of the population is involved in this field, which places Romania on the first place in the European Union [4], [1].

Agriculture is at a critical stage as it tries to balance its nutritional, economic and environmental requirements. One solution to these problems would be organic farming, which focuses on sustainability, human health, biological conservation and combines scientific knowledge and modern technology with traditional agricultural practices based on thousands of years of agriculture, where we must not forget crop rotation [12].

The transition from conventional to organic agriculture is gradual, so that it does not feel the effects of declining productivity, and producers gain confidence in organic systems [6].

All EU Member States must draw up work plans in this regard, so that by 2030 the percentage of organically cultivated areas will reach 25% at the level of each country. Romania currently utilizes about 3% of the registered area in the organic system [10].

Organic farming means a return to the values of traditional agriculture, but not to its methods [2], [5].

The new policy of the European Union emphasizes the importance and rise of this new sector of agriculture. Organic farming enters a new stage, characterized by mega-trends (neo-ecology, connectivity, globalization, etc.), which pursue the effects of social change [11].

MATERIALS AND METHODS

In this paper were studied four crops frequently present in crop rotation used by most farmers, namely, wheat, barley, corn and sunflower. The surfaces cultivated in organic system and in conventional system, in the period 2015-2020 were analyzed by comparison. The data related to organic agriculture were provided by the database of the Romanian Ministry of Agriculture and Rural Development and also, the documentation was performed through the TEMPO Online Database – National Institute of Statistics (INS) - 2020.

RESULTS AND DISCUSSIONS

Organic agriculture is the branch of agriculture that has registered the highest pace of development in the last 10-15 years worldwide, in the European Union and in Romania [13]. This has emerged as an alternative to the intensive, conventional (industrialized) practice of agriculture based on maximizing production by using inputs, energy-intensive production stimulators in large quantities, in order to continuously increase agricultural production for a population. constantly growing, mostly urban [9]. Although the fertilization used to practice conventional agriculture, increases production, the lack of fertilization in the organic system can be compensated with the practice of a proper crop rotation, this being crucial for organic agriculture [3].

Regarding the cultivated areas, in 2014 Romania had an agricultural area of over 14,600,000 hectares and an arable area of over 9,395,000 hectares. From the analysis of the evolution of cultivated areas with wheat, barley, corn and sunflower, in Romania, we see that of the four crops analyzed, corn is the crop in first place after the cultivated area, with an average of 2,515,726 ha, followed by wheat crop (Table 1). The largest area cultivated with corn was registered in 2019, when we observe an area of 2,678,504 ha [8]. The second place was occupied by wheat cultivation, followed by sunflower and barley (Figure 1).

Table 1. Areas cultivated with the main crops, in 2015-2020 period

Cultivated plants	The year					
	2015	2016	2017	2018	2019	2020
	- ha -	- ha -	- ha -	- ha -	- ha -	- ha -
Wheat	2,106,591	2,137,731	2,052,917	2,116,154	2,168,370	2,111,438
Barley	266,941	295,996	268,826	250,797	285,065	308,090
Corn	2,605,165	2,580,975	2,402,082	2,439,842	2,678,504	2,514,230
Sumflower	1,011,527	1,039,823	998,415	1,006,994	1,282,697	1,166,090

Source: TEMPO Online Database - NIS, 2021 [8].

Table 2. Land areas cultivated in organic system nationally, in 2015-2019 period (crops certified in organic agriculture)

The year	2015	2016	2017	2018	2019
Total area (organic system) (ha)	245,923.9	226,309.0	258,470.93	326,259.55	395,227.97
of which cereals (ha):	81,439.5	75,198.31	84,925.51	114,427.49	126,842.95

Source: Ministry of Agriculture and Rural Development [7].

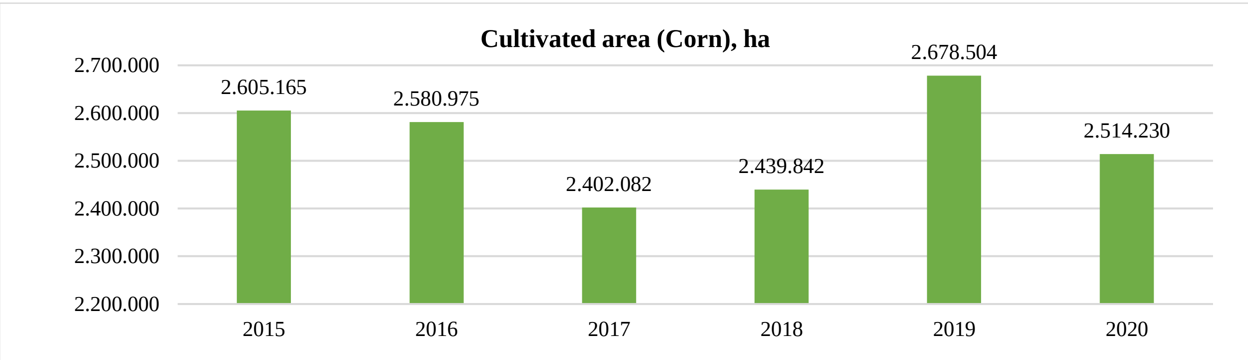

Fig. 1. Areas cultivated at national level with corn, in 2015-2020 period
Source: Own design based on NIS data, 2021[8].

Regarding the areas cultivated in organic system, nationally, we notice that if in 2015 an area of 245,923.90 ha was cultivated, of which 81,439.5 was occupied by cereals, in 2019, it increased by 60.7 % (Table 2).

Table 3. The dynamics of cultivated areas in conventional and organic system, in 2015-2020 period

Culture system	2015	2016	2017	2018	2019	Average
	- ha -	- ha -	- ha -	- ha -	- ha -	%
Conventional	3,883,633	3,916,794	3,669,323	3,697,633	4,246,266	92.51
Organic	245,923.9	226,309.00	258,470.93	326,259.55	395,227.97	7.48

Source: Ministry of Agriculture and Rural Development [7].

Analyzing the cultivated areas in organic system compared to the cultivated areas in conventional system [7], we observe that organic agriculture was practiced on small areas, on average 7.48% (Fig. 2).

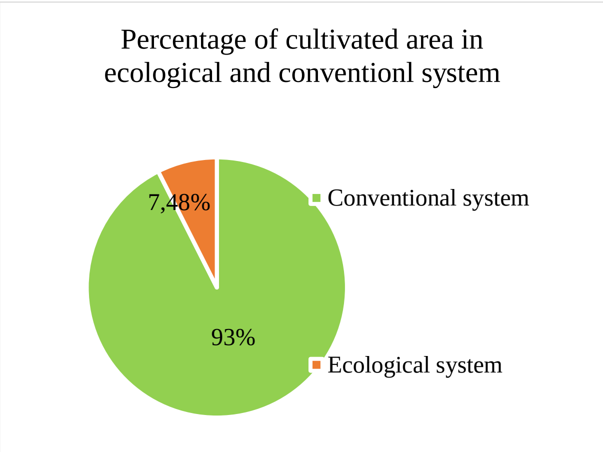

Fig. 2. Percentage of cultivated and area in organic and conventional system
Source: Own design based on the data from [7].

If we compare the cultivated areas in the conventional system, with the cultivated areas in the organic system, for the four crops analyzed, in the 2015-2019 period, we find that the highest percentage obtained by comparing the two methods was recorded by barley crop, even if, of the four crops analyzed, barley is the least cultivated compared to the other crops (Table 3).
The maize crop had the largest cultivated area in the traditional system (2,605,165 ha), of the four crops subject to analysis but the smallest cultivated area in the organic farming system 23,136 ha, which represents a percentage of 0.88 % of the total area (Table 4).
In the case of barley cultivation, the ratio is reversed, the smallest area is cultivated in the conventional system (266,941 ha) but in the organic system the area is 9,215, representing a percentage of 3.54%. Wheat and sunflower grown in an organic system, occupy modest areas of approx. 2 %.

Table 4. The evolution of cultivated areas in conventional and organic system, wheat, barley, corn and sunflower, in 2015

Culture	Cultivated area		
	Conventional system	Organic system	
	ha	ha	%
Wheat	2,106,591	42,854	2.03
Barley	266,941	9,215	3.45
Corn	2,605,165	23,136	0.88
Sunflower	1,011,527	21,983	2.17

Source: Ministry of Agriculture and Rural Development [7].

In 2016, wheat grown in the organic system occupied a percentage of 2.03%, along with sunflower, which occupied areas of 2.15% compared to areas grown in the conventional system (Table 5).
This year, corn remained the crop with the fewest hectares cultivated in an organic system, but the surface decreased compared to 2015, by 0.24%.
Sunflower had an insignificant decrease, from 2.17% in the organic system, in 2015, to 2.15%, in 2016 (Table 5).

Table 5. The evolution of cultivated areas in conventional and organic system, wheat, barley, corn and sunflower, in 2016

Culture	Cultivated area		
	Conventional system	Organic system	
	ha	ha	%
Wheat	2,137,731	43,494	2.03
Barley	295,996	5,690	1.92
Corn	2,580,975	16,643	0.64
Sunflower	1,039,823	22,426	2.15

Source: Ministry of Agriculture and Rural Development [7].

The sunflower crop registers a significant increase in 2017, the number of hectares cultivated in organic system with this crop increased from 21,983 ha in 2015 to 33,712 ha in 2017, registering an increase of 53.35%.

Barley has the largest areas cultivated in an organic system, these presenting a percentage of 3.59% compared to areas cultivated with corn in a conventional system (Table 6).

If we follow, in parallel, the evolution of the areas cultivated in conventional system, in 2017 compared to 2016, we find that the areas cultivated conventionally with wheat increase, but those cultivated in organic system decrease.

Table 6. The evolution of cultivated areas in conventional and organic system, wheat, barley, corn and sunflower, in 2017

Culture	**Cultivated area**		
	Conventional system	**Organic system**	
	ha	**ha**	**%**
Wheat	2,052,917	45,686	2.22
Barley	268,826	9,669	3.59
Corn	2,402,082	19,670	0.81
Sunflower	998,415	33,712	3.37

Source: Ministry of Agriculture and Rural Development [7].

In barley, the areas cultivated in a conventional system increase, but also those cultivated in an organic system. In corn and sunflower, the same tendency of decreasing the cultivated areas in conventional system is observed and those cultivated in organic system increase (Table 7).

Table 7. The evolution of cultivated areas in conventional and organic system, for wheat, barley, corn and sunflower, in 2018

Culture	**Cultivated area**		
	Conventional system	**Organic system**	
	ha	ha	%
Wheat	2,116,154	69,684	3.29
Barley	250,757	10,234	4.08
Corn	2,439,842	26,745	1.09
Sunflower	1,006,994	36,870	3.66

Source: Ministry of Agriculture and Rural Development [7].

In year 2018, the areas cultivated in an organic system increase in all four crops, the highest increase being in the wheat crop, the percentage being 3.29%, and the smallest area occupied in the organic system is recorded in the corn crop. with 1.09%.

Regarding the trend of conventional agriculture, compared to organic, we find that three crops have an increasing trend, namely wheat, barley and sunflower and corn occupies small areas of 1.09 % grown organically (Table 8).

According to the data from Table 8, the cultivated area continued to increase in the organic system for a single crop, although it is quite small, for the corn crop reaching a percentage of 1.37 % representing an insignificant increase of only 0.28 % 2019 compared to the year 2018.

Table 8. The evolution of cultivated areas in conventional and organic system, wheat, barley, corn and sunflower, in 2019

Culture	**Cultivated area**		
	Conventional system	**Organic system**	
	ha	ha	%
Wheat	2,168,370	70,383	3.24
Barley	285,065	11,425	4.00
Corn	2,678,504	36,719	1.37
Sunflower	1,982,697	46,460	3.62

Source: Ministry of Agriculture and Rural Development [7].

The other four analyzed crops lost from the areas cultivated in the organic system, but the areas cultivated in the conventional system increased.

CONCLUSIONS

Based on the this analysis, there were drawn the following conclusions:

-The areas cultivated in the organic system are quite small, they represent an almost insignificant percentage, varying between 0.81% and 4.0% for the four crops, in the analyzed period, 2015 - 2019, these increasing very little from one year to another.

-The average area cultivated with wheat, nationally, in recent years has been allocated to a process of 2.69%, of the total area cultivated with wheat nationally.

-In the case of barley, the largest area was cultivated in 2020, namely 308,090 ha, of which 4% was occupied by organic crops.

-Regarding organic farming, in Romania, 2019 was the year with the most hectares cultivated in this system, from 1.37% for corn, followed by wheat cultivation with 3.24% and sunflower cultivation with 3.62%.

-Year 2016 was the year with the smallest cultivated areas in organic system for wheat, barley and corn.

-At sunflower, the smallest area registered in the organic system was in 2015 when 21,983 ha were cultivated, after which it doubled, reaching 46,460 ha in 2019.

- Although the European Union supports the development of this system of organic farming by providing subsidies, Romanian farmers are hard to convince to adhere to this type of environmentally friendly agriculture, because the costs are quite high with such crops and, until they exceed the conversion period, farmers do not make a profit.

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MACRO ECONOMIC VARIABLES AND NIGERIA AGRICULTURAL TRADE FLOWS: A GRAVITY MODEL ANALYSIS APPROACH

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Abstract

The study examined the influence of macro-economic variables on agricultural trade flows between Nigeria and her trading partners. Time series data covering the period between 1970 and 2019 were used in the study. Data were analysed using descriptive statistics and a gravity model. Results of the descriptive analysis revealed a declining trend in earnings from agricultural exports, while expenditure on agricultural imports increased significantly, resulting in a deficit balance of agricultural trade in Nigeria over the study period. Results of gravity model analysis showed that exchange rate, agricultural export tax, Nigeria's Gross Domestic Product (GDP) and Nigeria's population positively influenced agricultural trade flows, while the distance between Nigeria and United Kingdom negatively influenced agricultural trade flows. The study concluded that bilateral agricultural trade between Nigeria and her trading partners in the study is elastic to exchange rate, agricultural export tax, Nigeria GDP, Nigeria population, and distance between Nigeria and United Kingdom. Thus, effective and efficient monetary and fiscal policies to monitor exchange and export tax in the economy and improved bilateral trade agreements will ensure a friendly macro-economic environment that will stimulate mutual benefits from agricultural trade for both partners.

Key words: *gravity model, agricultural export earnings, exchange rate, inflation rate, agricultural export tax*

INTRODUCTION

Prior to independence, agricultural exports such as cocoa, palm oil, palm kernel, rubber, cotton and beni-seed constituted a significant proportion of Nigeria's export trade. Other non-oil export commodities are cattle, hides and skin, tin-ore and columbite [3].
However, the discovery oil and its subsequent boom in the early 1970s relegated agricultural exports and become the major source of revenue for the nation. The situation was seriously aggravated in the 1980s plunging the country into serious balance of trade and payment problems [9] and [10].
According to [1] and [14] fluctuations in income earned from production of agricultural export commodities comes from either an increase or a decrease in the prices of agricultural export commodities in international market or increase in producer prices because of currency devaluation. Changes in price/exchange can result in decline in future production of agricultural export commodities which will aggravate risks and uncertainty in international agricultural trade flows, which in turn will discourage agricultural trade.
[13] argued that instability in exchange rate will induce undesirable macroeconomic phenomena such as inflation and domestic trade protection which are both detrimental to agricultural trade flows.
In Sub-Saharan Africa, many countries embraced the Import Substitution Industrialization (ISI) strategy which involved substitution of expensive imports with locally produced cheap alternatives in order to achieve sustained economic growth. In Nigeria, agriculture is the mainstay of the economy, thus, ISI is expected to improve productive capacity of the agricultural sector, especially agricultural exports sub-sector. ISI stimulated increase in production and export volumes of agricultural commodities which led to appreciation in the value of naira relative to other currencies of Nigeria's trading partners [14].

In an effort to restructure the economy, the federal government of Nigeria introduced the Structural Adjustment Programme (SAP) in 1986. This programme was aimed at solving country's balance of trade and payment problems. However, SAP did not yield the desired results as the food import bills continue to soar [1].

One of the economic implications of SAP is the devaluation of the country currency under Bretton wood system as recommended by international financial organizations (International Monetary Fund (IMF) and World Bank (IBRD)). The devaluation is expected to stimulate economic growth and development, consequently, low profits from exports significantly reduced the performance of the export sector [2].

Conventionally, the gravity model first application to international trade flows analysis was cited by [12], is credited to the contemporary and independent work of [17] and [15]. In standard form, the gravity model as explained by [19], is specified the volume of bilateral trade between any two trading partners is an increasing function of their sizes of income and a decreasing function of the geographical distance between the trading partners.

[5] asserted that under apriori expectation, bilateral trade is positively associated with the income and negatively associated with the geographical distance between the two countries. Although, the gravity model have been presumed as a powerful tool in analyzing bilateral trade flows by various authors ([18], [16], [11], [20]) it was heavily criticized for being deficient in theoretical justification.

However, the works of [4] and [6] who derived gravity equation models from trade models of product differentiation and increasing returns to scale disapproved this assertion, [12] also showed that the gravity equation can be derived within Ricardian and Hecksher-Ohlin models framework. This affirms that the gravity model, provides a very important empirical analytical tool.

This study examines the determinants of agricultural trade flows between Nigeria and her trading partners, with the specific objectives of describing export destinations of agricultural export commodities and isolating the effects of macro-economic variables such as exchange rate, interest rate, inflation rate and export tax on agricultural trade flows.

MATERIALS AND METHODS

The data set for the study were obtained from secondary sources. Data on the values and volumes of agricultural export commodities, as well as gross domestic product (GDP) of both exporting and importing countries were obtained from Food and Agriculture Organization (FAO) Statistical Database (FAOSTAT), while data on variables such in exchange rate, inflation rate, geographical distances and population were obtained from the publications of the Central Bank of Nigeria (CBN) and the National Bureau of Statistics (NBS). The selected agricultural export commodities for this study are cocoa beans, palm oil, palm kernels and seed cotton. The analysis covered the period between 1970 and 2019.

Data were analyzed using both descriptive and inferential statistics. The descriptive statistics such as means, graphs and tables were used to describe trend in agricultural trade in Nigeria between 1970 and 2018. The inferential statistical tool employed in the study to isolate significant determinants of agricultural trade flows is the gravity model regression analysis. Prior to this, time series characteristics of the variables employed in the study were examined for unit root (non-stationary) using the Augmented Dickey Fuller (ADF) technique and are made stationary by differencing in order to avoid spurious regression associated with time series data.

In trade analysis, the mass of the bodies are represented by the gross domestic product (GDP) of the exporting and importing countries, while distance is measured as the shortest possible distance measured in kilometres between the two trading countries. In empirical studies, policy variables are added to assess and estimate deviations from the baseline trade flows. The model has a significant explanatory power in trade analysis [12] and [8].

In estimation, the gravity model is usually specified in natural logarithmic functional form, linking the bilateral trade flows of individual country pair to the product of their GDPs, per capita GDPs, population and the distance between them plus an error term to capture the random component in the data. In most applications, additional independent variables are also often included in the model to improve the fit [7].

In this study, the included variables are exchange rate, inflation rate and export tax. A language dummy for a country pair is assigned 1 if they share a common language and 0 otherwise. The selected agricultural export commodities for this study are cocoa, palm kernel, seed cotton, cashew nuts and ginger. The analysis covered the period between1970 to 2019.

The empirical form of the model that was used in this study is given as follows:

$$\ln Y = \ell_0 + \ell_1 \ln X_1 + \ell_2 \ln X_2 + \ell_3 \ln X_3 + \ell_4 \ln X_4 + \ell_5 \ln X_5 + \ell_6 \ln X_6 + \ell_7 \ln X_7 + \ell_8 \ln X_8 + \ell_9 \ln X_9 + \ell_{10} \ln X_{10} + \ell_{11} X_{11} \quad \text{………………………………..(1)}$$

where:

$\ln Y$ is the log of value agricultural exports from Nigeria.

$\ln X_1$ is the log of volume of agricultural exports from Nigeria

$\ln X_2$ is the log of value of agricultural imports from trading partners

$\ln X_3$ is the log of real exchange rate

$\ln X_4$ is the log of export tax levied on agricultural export commodities valued in Naira

$\ln X_5$ is the log of rate of inflation in the economy

$\ln X_6$ is the log of Gross Domestic Product (GDP) of Nigeria

$\ln X_7$ is the log of Gross Domestic Product (GDP) of Nigeria's trading partners

$\ln X_8$ is log of the population of Nigeria

$\ln X_9$ is the log of population of Nigeria's trading partners

$\ln X_{10}$ is the log of distance, measured in nautical miles between Nigeria and her trading partners

$\ln X_{11}$ is the log of language dummy (1 for the same language 0 otherwise)

ℓ_0 is the constant of the regression

ℓ_1----- ℓ_{11} are parameters to be estimated

The selected Nigeria's trading partners for this study are United States of America and United Kingdom.

RESULTS AND DISCUSSIONS

Trend in Agricultural Trade in Nigeria (1970-2019)

The trend in agricultural trade flows in Nigeria between 1970 and 2019 is presented in Table 1 and Figure 1. The table and figure reveals that the average values of agricultural exports decreased progressively from 1970-79 sub-period to 1990-99 sub-period, but rose significantly during the 2000-09 and 2010-19 sub-periods. The average value of agricultural exports for the period under study is \$322,393.5.

Similarly, the average volume of agricultural imports rose significantly between 1970-79 and 2010-19 sub-period. The average value of agricultural imports for the period under study is \$343,247.7.

Table 1. Trend in Agricultural Trade in Nigeria (1970-2019)

Sub-period	Average value of Agricultural Exports (\$)	Average value of Agricultural Imports (\$)	Average balance of Agricultural Trade (\$)
1970-79	316,106.8	34,129.0	231,977.8
1980-89	244,311.1	174,694.3	69,616.8
1990-99	173,661.0	136,755.4	3,905.6
2000-09	353,174.9	383,979.7	-269,077
2010-19	547,193.6	1,002,617	-455,423.4
All period	**322,393.5**	**343,247.7**	**-1,130,000**

Source: Computed from FAOSTAT, NBS and CBN Statistical Bulletin, 2020.

However, average balance of agricultural trade decreased progressively over the period of the study, with a deficit balance of agricultural traded recorded during the 2000-

09 and 2010-19 sub-periods. The average agricultural balance of trade over the study period is $-1,130,000.

In summary, there was a declining trend in earnings from agricultural exports, while expenditure on agricultural imports increased significantly, resulting into a deficit balance of agricultural trade during the period of the study.

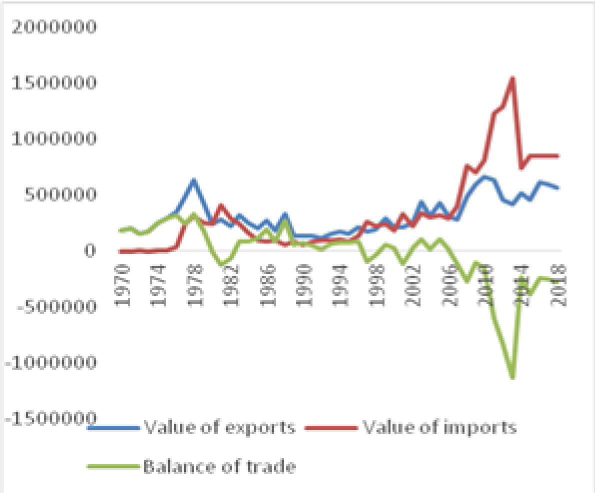

Fig. 1. Trend in Agricultural Trade in Nigeria (1970-2019)
Source: Author computation, 2020.

Result of Gravity Regression Analysis of the Determinants of Agricultural trade Flows between Nigeria and United States of America

The result of gravity regression analysis of the determinants of agricultural trade flows between Nigeria and United States of America is presented in Table 2. The coefficient of determination (R^2) is 0.74 and the F- statistic is 124.30 which is statistically significant at 1% level, showing that the model has a good fit.

Table 2 presents the result of gravity regression analysis for United States of America. The coefficients of log of exchange rate (X_3), Nigeria gross domestic product (GDP) (X_6) and log of export tax on agricultural export commodities (X_4) are significant at 1%, 1% and 5% level respectively. The result implies that bilateral agricultural trade flows between Nigeria and United States of America is highly elastic to exchange rate, Nigeria GDP and export tax on agricultural commodities.

This result implies that an increase in bilateral agricultural trade flows between Nigeria and United States of America would boost Nigeria's output capacity of agricultural export commodities, and would improve agricultural export earnings and revenue generated through export taxes on agricultural export commodities traded with the United States under an agricultural exports friendly exchange rate.

Table 2. Result of Gravity Regression Analysis of the Determinants of Agricultural Trade Flows between Nigeria and United States of America.
Dependent Variable = Ln Y

Variable	Coefficient	Standard Error	t-Statistics	Probability
$\ln X_1$	6.646	4.406	1.508	0.144
$\ln X_2$	-12.097	11.008	-1.099	0.282
$\ln X_3$	30.267	8.119	3.727	0.001*
$\ln X_4$	36.416	16.444	2.214	0.036**
$\ln X_5$	-33.620	734.304	-0.046	0.936
$\ln X_6$	11.024	4.734	2.326	0.028*
$\ln X_7$	6.262	12.637	0.495	0.624
$\ln X_8$	0.230	0.482	0.478	0.637
$\ln X_9$	-25.864	45.024	-0.574	0.571
$\ln X_{10}$	11.195	13.586	0.824	0.418
$\ln X_{11}$	83.553	666.909	0.125	0.901
Constant	-11.525	4.848	-2.377	0.225
R^2 = 0.74				
F = 124.30*				

Source: Data Analysis, 2020
*Coefficient significant at 1% level.
**Coefficient significant at 5% level

Result of Gravity Regression Analysis of the Determinants of Agricultural trade Flows between Nigeria and United Kingdom.

The result of gravity regression analysis of the determinants of agricultural trade flows between Nigeria and United Kingdom is presented in Table 3.

The values of coefficient of determination (R^2) and F statistic are 0.63 and 121.40 respectively. The F-value is statistically significant at 1% level. This shows that the model has a good fit. The result of gravity regression analysis for United Kingdom reveals that the coefficients of log of exchange rate (X_3), log of Nigeria's GDP (X_6) and log of Nigeria's population (X_8) are positive and statistically significant at 1%, 5% and 1% level respectively This result exerts that bilateral agricultural trade between Nigeria and United Kingdom is positively elastic to exchange rate, Nigeria's GDP and Nigeria's population.

Conversely, the coefficient of log of distance between Nigeria and United Kingdom is negative and statistically significant at 1% level.

This result implies that expansion in market size of Nigeria and output capacity of agricultural export commodities are factors that would facilitate bilateral agricultural trade flows between Nigeria and the United Kingdom. However, distance between markets of both countries would impede bilateral agricultural trade flows. This might be due to high logistics and transportation cost incurred by exporters as a result of higher value of pound sterling relative to the naira.

Table 3. Result of Gravity Regression Analysis of the .Determinants of Agricultural Trade Flows between Nigeria and United Kingdom

Dependent Variable = Ln Y

Variable	Coefficient	Standard Error	t-Statistics	Probability
lnX_1	6.646	4.406	1.508	0.144
lnX_2	=12.67	50.119	-0.604	0.550
lnX_3	8.409	2.085	4.029	0.000*
lnX_4	-12.097	11.008	-1.099	0.282
lnX_5	-11.525	9.585	-1.202	0.318
lnX_6	4.341	1.734	2.503	0.028**
lnX_7	-0.046	0.248	-0.186	0.854
lnX_8	5.208	1.038	5.07	0.000*
lnX_9	12.340	9.204	1.341	0.190
lnX_{10}	-40.639	15.784	-2.574	0.052**
lnX_{11}	3.396	11.983	0.283	0.779
Constant	-10.545	7.840	-1.345	0.225
R^2 = 0.63				
F = 121.40*				

Source: Data Analysis, 2020

*Coefficient significant at 1% level.

**Coefficient significant at 5% level

CONCLUSIONS

This study examined the influence of macro-economic variables (exchange rate, inflation rate and export tax on agricultural export commodities) on agricultural trade flows between Nigeria and her trading partners.

The study concluded that bilateral agricultural trade between Nigeria and her trading partners in the study is elastic to exchange rate, agricultural export tax, Nigeria GDP, Nigeria population and distance between Nigeria and United Kingdom.

Based on the findings from the study, there is need for effective and efficient monetary and fiscal policies to monitor exchange and export tax in the economy in order to provide conducive macro-economic environment that will stimulate and promote agricultural trade flows. This will help to maximize earnings from agricultural exports.

There should also be improved bilateral trade agreement between Nigeria and her trading partners, this will ensure a friendly macro-economic environment that will stimulate mutual benefits from agricultural trade.

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ANALYSIS OF THE INDICATORS CHARACTERIZING THE ACTIVITY OF RURAL TOURISM AND AGRITOURISM IN VÂLCEA COUNTY FROM THE PERSPECTIVE OF THE TOTAL QUALITY

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Abstract

The paper carried out a relevant, realistic and clear image on the current situation of rural tourism and agrotourism in terms of defining quality indicators and service offering to tourists visiting Valcea County. To achieve this, ten representative indicators were studied, based on which a system of quantification of the level of total quality management (TQM) was built, of the rural tourism activities carried out in this county. From the analysis and interpretation of the data and results obtained, it was concluded that the level of supply and services provided to tourists in terms of total quality is average, this is mainly due to low tourism supply, lack of a complete inventory of tourism resources, the partial capitalization of the existing resources, the lack of initiative and a tourism development strategy adapted to the territorial reality. Finally, it was concluded that the main directions for the development of rural tourism in Vâlcea County will have to aim at increasing the quality of tourist services, diversifying the tourist offer and more aggressively promoting the county as a tourist destination. The implementation of the principles of total quality management (TQM) should in the future determine all tourist reception structures to give more importance to customer expectations, which will lead to increasing their competitiveness in the domestic and foreign tourism market.

***Key words*:** *agrotourism, quality, management, rural tourism, tourist resources*

INTRODUCTION

As is well known, rural tourism and agrotourism drive the economic development of rural areas, because they create added value, being thus likely to participate in achieving the social goal of improving the physical and mental well-being of the population [4, 22]. Due to tourism, even declining rural or industrial regions have managed to find activity that has the power to recycle devalued objects and give them new meanings and uses [14, 6, 20]. However, it has been found that where tourism development has been influenced by Fordist principles of growth-based development, it has had negative effects, leading to the degradation of the environment and resources that favor tourism. [16, 26, 31]. This is the case of resorts that have promoted mass tourism in attractive but ecologically fragile places. They are currently going through a crisis of adaptation to new tourism practices and modern concepts of development, based on sustainable development [10, 18, 19, 32].

In the vision of sustainable development, the Romanian rural tourism requires a complex approach, which includes both the actual tourist activity (accommodation, boarding house, tourist and leisure programs), and the agricultural activity of obtaining the products necessary for tourist consumption and their processing in households [1, 3, 24]. Rural tourism and agrotourism are economic activities that, in the last two decades, have seen a wide development with the growing desire of tourists to escape from crowded and polluted cities and to spend their holidays in rural areas unchanged from a natural and anthropic point of view. [5, 7, 12].
Rural tourism with the specific form of agrotourism as found in studies can economically revitalize villages, can contribute to infrastructure modernization, can attract different investors, if the inhabitants of rural areas adopt a favorable attitude, which is correctly received by tourists who prefer this type of tourism, and whether local authorities are sufficiently involved in the development of this profitable economic activity. There

will be positive influences on the environment, agriculture, transport, construction, food and processing industries, services in various fields [7, 15, 28].

The paper started from the premise that local resources are an important engine of local economy development. In Vâlcea County the tourist potential is extremely rich and diversified and the maximum use of natural, economic and human resources can be achieved by involving local communities in the tourism sector, by supporting initiative groups for developing and promoting the local tourist offer, to protect the environment and cultural goods [2, 6, 9]. In order for the capitalization action to be efficient, it is necessary to know all the resources with existing tourist potential in the territory and to determine their tourist value, in this county being a series of resources, not promoted at their true value and known only by locals [9, 30]. For this, a tool for quantifying the tourist value must be built, which aims to determine the territorial concentration of tourist resources, based on the application of the principles of total quality in agrotourism and rural tourism in the studied county [8, 10, 27].

MATERIALS AND METHODS

In order for the capitalization action to be efficient, it is necessary to know all the resources with existing tourist potential at the level of the territory and to determine their tourist value. In this paper we could not focus much on this study, because we would have needed a much larger space for presentation than that allocated to such a paper. Even if in the study region there are a series of resources with tourist potential, not promoted and known only by locals, but they do not intuit their tourist value, we considered that from this point of view there is enough information so that we can get an image of overall, on the current situation of the natural and anthropic tourist potential of Vâlcea County. The study aims to determine the territorial concentration of tourist resources, allowing the further development of territorial tourism systems that allow optimal use of these resources, based on the principles applied in total quality management (TQM) [11, 13], which will ensure future growth the quality of rural tourism products and services in this county.

In order to obtain relevant data on the physical and economic components of rural tourism in the researched area, data was collected from all rural tourism associations in the county, with the most accurate being that from the National Association of Rural, Ecological and Cultural Tourism (A.N.T.R.E.C), from owners, employees and tourists [2, 3, 33.17]. Also, in order to form a real picture about the current situation of rural tourism from all points of view (natural, economic and social), many publications about the county were studied (monographs, works of county and local authorities, web pages, etc.), the normative acts that regulate the development of the activity at local and national level, as well as many specialized studies published at national and international level [7, 8, 12, 20, 22, 30, see references]. From a methodological point of view, in this research were used various statistical methods and procedures, among which teh most important ones are: Index and indicators method, monograph procedure, statistical report method, scalar method, and also records, and methods utilized by [7, 23, 29].

In order to make a comparative analysis, the following system of specific indicators was used regarding tourism offer: accommodation capacity in terms of the number of places, and tourism demand: number of arrivals at the guesthouse, number of overnight stays at the guesthouse. Also, other indicators reflecting the quality of the tourist activity and of the tourist circulation were taken into consideration [7, 8,13, 17]. These indicators helped form a clear image of the quality in the rural tourism activity in Vâlcea County.

The other methods such as statistical monographs, selective surveys, consultation of statistical reports and the method of direct and occasional registration were applied by consulting leaflets, tourist guides, magazines, etc., and conducting interviews / discussions with all actors involved in this complex and beautiful, the activity rural tourism in Vâlcea County [3, 9, 21, 30, 33]. Following these discussions and interviews, a complete and well-documented study on the current stage of development of the rural tourism activity in terms of the application of total quality management took shape and the ability to formulate a series of principles and directions, which should be followed in the future by the development of tourism in general, in the researched area [7, 8, 13].

RESULTS AND DISCUSSIONS

Vâlcea County has an enormous tourist potential, now in a process of resuscitation. Due to its geographical location, Vâlcea benefits from a great variety of landforms: mountains, sub-Carpathian hills, plateaus, meadows with the appearance of plains, gorges and depressions, as well as a rich and diverse flora and fauna [25]. In addition to the rich natural tourist potential, Vâlcea County also has an anthropic nature that brings together a wide range of major objectives: historical tourist objectives; religious tourist attractions; cultural tourist objectives; tourist buildings proper; anthropic activities with tourist functions [2, 9, 30]. This category includes a wide range of constructions and material evidence from millennia and centuries past. They address exclusively cultural tourism, recreation through knowledge, having at the same time an important educational function. In Vâlcea County, the elements of material and spiritual culture have created a distinct personality, which greatly increases its tourist value [2, 9, 30].

From the study of the area it was observed that the tourist offer of the county is reduced in comparison with the rich natural and anthropic tourist potential held with other tourist regions in Romania. In addition, a series of resources that, through tourism capitalization, could attract tourists to Vâlcea County and would represent a source of income for it is degraded due to the lack of capitalization initiatives.

In order to determine to what extent the tourist potential of the existing resources in Vâlcea County can be capitalized, we resorted to building a system for assessing their tourist value, which has the role of evaluating not only the quantitative aspects of tourist resources, but also qualitative.

Based on the study, the data obtained, were calculated and interpreted the statistical indicators mentioned in the methodology, which characterizes the activity of rural tourism and agrotourism in Vâlcea County, from the perspective of total quality. The level and dynamics of the tourists arriving in the rural tourist boarding houses in the county were highlighted. More than half of the existing communes in Vâlcea County have tourist potential, presenting a significant degree of tourist attractiveness, making it opportune to develop rural tourism. However, only 3.5% of all rural localities have tourist pensions.

Rural tourist pensions in Vâlcea County

Until December 31, 2019, Vâlcea County had 78 rural localities in which 79 rural tourist pensions and 78 agrotourism pensions were identified, of which only a small part of them are classified (Figure 1). The refusal of the classification of these pensions by the owners leads to the realization of an unfair competition with the classified pensions and induces certain doubts regarding the quality of the tourist services provided and implicitly of the rural tourist product offered.

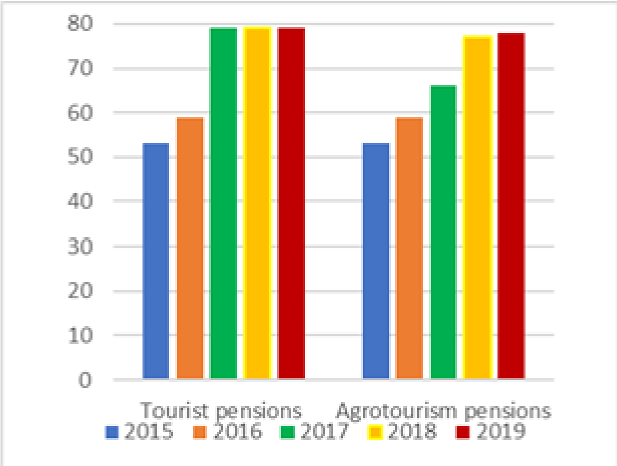

Fig. 1. The evolution of rural tourist boarding houses with accommodation functions in Vâlcea County
Source: processing the field observations and data from National Institute of Statistics, 2021.

The trend of increasing the number of rural tourist pensions in Vâlcea County in the period 2015-2019 is highlighted. This is the result of the development of rural tourism in general, the preferences of potential tourists being oriented towards diverse, recreational activities, carried out in a less polluted space. This is due to the fact that most of them were developed on the already existing homes of entrepreneurs. Pensions classified in higher comfort categories (4 and 5 stars/daisies) are in very small numbers due to the low financial strength of those who want to invest in this field.

Accommodation capacity in rural tourist boarding houses in Vâlcea County

In the period 2015-2019 there was a continuous growth in the existing accommodation capacity as a result of the increase in the number of rural tourist guesthouses in the county (Table 1).

In the tourist pensions in the county, the accommodation capacity in terms of places days increased from about 336 thousanda in 2015, to 498 thousands in 2019, and in the agro-tourist pensions it increased from 281 thousands in 2015, to 382 thousands in 2019 (Table 1). The increase is explained by the desire of the locals to start their own business in order to obtain additional incomes to the basic ones, as a result of the increase of the requirements for practicing rural tourism.

Arrivals in rural tourist boarding houses in Vâlcea County

From the above it is clear that the demand for this specific form of tourism has increased considerably due to the relatively low prices charged by rural reception facilities, which are accessible especially to the population with low to medium incomes, who are able to use the income they have as efficiently as possible for recreation.

Table 2 shows that an increasing number of tourists prefer to stay in tourist and agritourism pensions in the county, the number of arrivals in tourist and agritourism pensions in 2019, practically doubled compared to 2015, reaching 39,506 in tourist pensions and 26,536 in agritourism pensions. This phenomenon viewed from the point of view of classification by comfort categories is due in the first place to the financial situation faced by tourists and the good quality / price ratio, offered especially by agritourism pensions.

Table.1. The capacity of tourist accommodation in operation in the rural tourist pensions from Vâlcea county between the years 2015-2019

No. places days in:	2015	2016	2017	2018	2019
Tourist pensions - total country	9,416,908	9,706,739	10,413,485	10,644,927	10,454,735
Pensions Vâlcea county	335,769	389,628	471,735	499,380	497,679
Agrotourism pensions-total country	9,079,901	10,336,702	11,787,897	12,498,050	12,615,982
Agrotourism pensions Vâlcea county	280,718	284,523	338,437	361,844	381,505

Source: processing the field observations and data from National Institute of Statistics, 2021.

Table 2. Arrivals of tourists in tourist reception structures in Vâlcea County

Year/ No. of arrivals	2015	2016	2017	2018	2019
Tourist pensions	21185	29751	36884	37502	39506
Agrotourism pensions	13525	17029	20635	23476	26536

Source: processing the field observations and data from National Institute of Statistics, 2021.

Overnight stays in rural tourist boarding houses in Vâlcea County

In the period 2015-2019 there is an upward evolution of the number of overnight stays at the level of all comfort categories. Thus, as shown in Table 3, overnight stays in tourist boarding houses registered a maximum in July and August, these being 9,608 in July 2015 and doubling in August 2019, reaching 18,662, due to leisure affected by the population of our country to tourism in these summer months, when most people take their vacation, spending their holidays in mountains or at sea. Also, there is a doubling of the number of overnight stays in 2019, compared to 2015, reaching 88,544. The same phenomenon of significant growth is found at the level of agritourism pensions, increasing from 22,961 in 2015 to 56,909 in 2019.

Table 3. Overnight stays in rural tourist boarding houses in Vâlcea County

Tourist pensions Year/month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
2015	1,128	1,154	2,690	2,403	3,832	4,887	9,608	4,820	4,583	3,169	3,355	4,379	46,008
2016	3,590	4,179	3,408	5,044	4,458	6,524	11,160	12,097	6,582	5,950	5,920	6,359	75,271
2017	3,658	2,330	3,844	5,077	5,468	9,274	13,814	13,862	7,942	7,078	6,310	5,969	84,626
2018	3,565	3,177	3,478	5,180	6,404	7,653	13,148	15,971	10,430	6,594	4,611	4,668	84,879
2019	3,745	3,655	3,256	4,813	5,675	9,180	16,334	18,662	11,182	6,122	4,145	1,775	88,544
Agrotourism pensions Year/month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
2015	1,707	1,702	1,456	1,534	2,057	2,143	4,450	1,935	1,427	1,124	1,775	1,651	22,961
2016	2,265	2,407	2,119	1,662	2,221	2,888	4,970	6,848	3,548	1,878	1,651	2,923	35,380
2017	2,664	2,091	1,729	2,138	2,333	3,843	5,729	7,069	3,288	2,321	1,900	3,092	38,197
2018	2,899	2,326	1,964	2,373	2,568	4,078	5,964	7,304	3,523	2,556	2,135	3,327	41,017
2019	4,223	4,668	3,228	3,697	3,892	5,402	7,288	8,628	4,847	3,880	3,459	4,651	56,909

Source: processing the field observations and data from National Institute of Statistics, 2021.

Tourism demand indicators

From the analysis it was found that the highest tourist demand in the research period was in rural tourist pensions classified at 2 daisies, so a lower category of comfort, followed by those classified at 3 daisies, at an average category of comfort. This is due to the fact that the largest segment of tourists come from the population with modest incomes and that the offer of these pensions in relation to quality/price, is an attractive one. The noticeable demand for the average comfort category is a result of the increase of tourists' demands for a better quality of the rural tourist product and services, materialized in the degree of comfort (Figure 1).

Indicators of tourist traffic

In order to highlight the tourist traffic, the total number of tourists (∑T) arriving in the area researched was inventoried in Table 4: of these, in 2019, approximately 39,506 arrived at the rural tourist pensions, while in the agritourist pensions the number was 26,536. Furthermore, the average number of tourists who arrive daily at the pensions in the rural area was taken into consideration, this being 108, in 2019, and in the agrotourism pensions it was lower, 73 tourists.

The intensity of the tourist traffic

The quantification of tourist traffic was performed by tracking the number of days per tourist (ZT) (Table 4) and the average length of the stay (D) (Table 5), based on which the density of tourist traffic (f1) was obtained, which was 0.1898 in the year 2019/ inhabitant, i.e. approximately 19 tourists/100 inhabitants.

Indicators of the tourist offer

The following indicators were studied:

A) Total number of rural tourist accommodation units/pensions (places)

Accommodation capacity comes in two forms:

a) existing accommodation capacity Cext

The existing accommodation capacity at the rural tourist boarding houses in Vâlcea County in 2019 was 2,409 places in 157 boarding houses.

b) accommodation capacity in function Cf

Following the study and the discussions with the owners of boarding houses in the localities in the county, it is found that they operate seasonally, different depending on the geographical location, season and leisure possibilities. At the county level, in 2019, the total number of places available in rural tourist structures with accommodation function is the highest for those with a lower comfort category (2 daisies/stars). One of the factors that generated this is the low financial potential of pension owners who have arranged their accommodation in their own homes, with a minimum of investment.

Table 4. Number of tourist days in 2019 at rural tourist boarding houses in Vâlcea County

Pensions	No. of tourists (Xi)	Overnights (Yi)	No. tourist days (ZT)
Rural tourism	39,506	88,544	3,498,019
Agrotourism	26,536	56,909	1,510,137
Total	66,042	145,453	5,008,156

Source: processing the field observations and data from National Institute of Statistics, 2021.

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Table 5. Evolution of the average duration of tourists' stay (days) at rural tourist boarding houses in Vâlcea County during 2015-2019

Pension/Year	2015	2016	2017	2018	2019
Rural tourism	2.17	2.53	2.29	2.26	2.24
Agroturism	1.69	2.07	1.85	1.96	2.14
Total	1.98	2.36	2.13	2.14	2.20

Source: processing the field observations and data from National Institute of Statistics, 2021.

Out of the total accommodation capacity in operation at the rural tourist pensions, by comfort categories, in Vâlcea county, in 2019, the first place is occupied by those classified at 2 daisies/stars, so those with a low degree of comfort, followed by 3 daisies/stars, with a medium degree of comfort. This ranking has as main factors, in addition to the financial potential of entrepreneurs in those localities and many other factors related to quality/price and the financial possibilities of the low-income population who prefer to practice such tourism, factors that have repercussions on the number of days of operation of tourist and agritourism pensions (Figure 2). Also in this category are: infrastructure that in certain seasons makes it impossible to access certain tourist routes, no snow or its existence for a short period of time, which makes it impossible to practice winter sports, insufficient promotion due to lack of funds allocated etc.

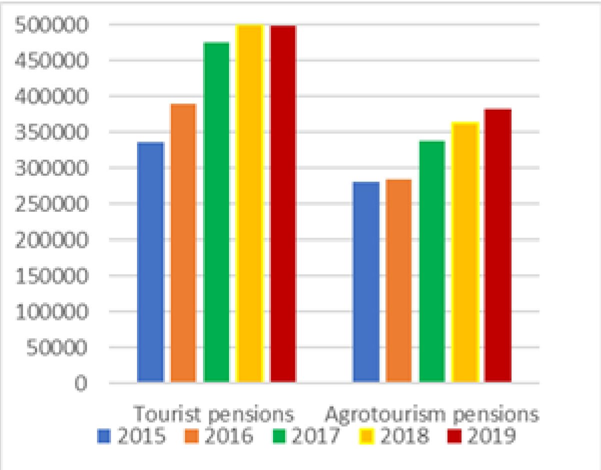

Fig. 2. The structure of the accommodation capacity in operation (places - days) at the rural tourist pensions and the agrotourism pensions in Vâlcea county in the period 2015-2019
Source: processing the field observations and data from National Institute of Statistics, 2021.

B) Maximum theoretical offer in units-days

The high values of the maximum theoretical offer registered in the lower comfort categories, of three and two daisies, outline the idea that entrepreneurs in this field had minimal financial potential to set up such reception structures, not particularly pursuing a high quality level of the tourist product offered (Figure 3).

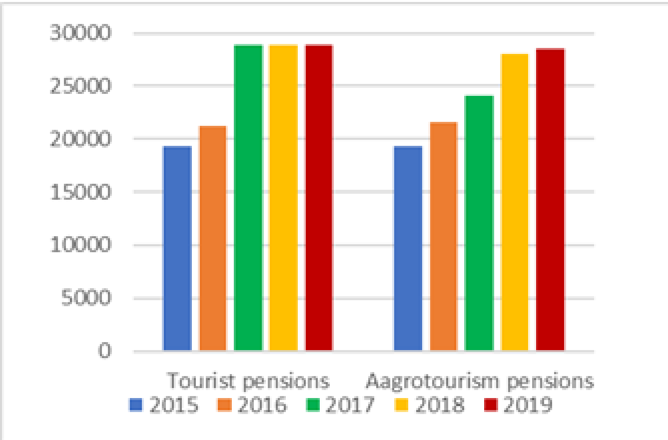

Fig. 3. The structure of the theoretical offer of rural tourist pensions and agrotourism pensions in Vâlcea County in the period 2015-2019
Source: processing the field observations and data from National Institute of Statistics, 2021.

C)Actual (real) offer in units-days

The largest effective offer of rural tourist pensions classified by localities and comfort categories, in Vâlcea County, in 2019 stands out in the lower comfort category, respectively in the two daisies guest house. The fact that most pensions in the county are in this category of comfort, as well as the large number of days of operation of those pensions, have influenced in this regard the actual offer. At the county level, the actual offer does not aim at a high degree of comfort, it being reduced to a lower quality level.

Indicators that characterize the efficiency of using the technical-material base of accommodation

A) The index of utilization of the accommodation capacity in operation

At the level of Vâlcea county in 2019 only 54.5% of the accommodation capacity in operation was used. The highest efficiency of using the accommodation capacity in operation is at the pensions with a lower quality level of comfort, respectively three and two daisies/stars. This is also due to the large number of pensions owned by Vâlcea County in this category, but also to the fact that most tourists came from the category of low-income social strata, who could not afford to pay higher accommodation rates, from pensions with a high quality level.

B) Occupancy rate of the accommodation unit

There is a low occupancy rate in Vâlcea County in 2019, i.e. only 16.32% of the accommodation capacity was occupied. The highest percentage in terms of occupied accommodation capacity is held by rural tourist pensions classified at 2 daisies/stars, so those with a lower quality level in terms of comfort, followed at a great distance by those of 3 daisies/stars. There is a trend of encouraging an increase in the accommodation capacity occupied in boarding houses with a medium degree of comfort. So, there has been a segment of tourists, with average incomes, who want to spend their free time in boarding houses with a medium quality level, in terms of comfort, which should boost pension management in reconsidering the quality of services provided.

Indicators of the quality of rural tourism activity

Among the indicators of the quality of rural tourism activity were subjected to the study:

A) Offer quality indicators

In order to determine the quality of the offer, the degree of comfort and endowment of the existing rural tourist pensions in Vâlcea County was taken for analysis. There is a timid annual increase in the quality of accommodation services, viewed in terms of comfort, by the appearance and increase in the number of rural tourist pensions classified at 3, 4 and 5 daisies/stars.

B) Indicators of social effects

In this study, only the following parameters were taken into consideration: number of rural tourist reception structures per 10,000 tourists and the structure of the accommodation capacity by comfort categories. Based on the data presented above, it can be estimated that the number of rural tourist reception structures, per 10,000 tourists in 2019 is 24.

The level and dynamics of tourists arriving in rural tourist boarding houses in Vâlcea County

The highest average level is noticed at the tourist pensions, respectively 32,966 people, out of the total number of tourists accommodated in the rural tourist pensions from Vâlcea county. The total number of tourists accommodated in rural tourist pensions in Vâlcea County in the period 2015-2019 increased on average by 6,266 tourists annually. This is influenced by the large accommodation capacity existing in these pensions and not particularly by the qualitative factor (Table 6).

Table 6. Dynamics of the number of tourists in rural tourist pensions in Vâlcea County during 2015-2019

Rural tourist pensions	Medium level (y)	The average index (I)	The average rate (R%)
Tourist pensions	32,966	1.169	16.9
Agrotourism pensions	20,240	1.184	18.4
Total	52,216	1.1765	17.65

Source: processing the field observations and data from National Institute of Statistics, 2021

Table 7. Estimated values of the number of tourists according to the linear trend for the period 2015-2019

Pensions/Year - no. people	2015	2016	2017	2018	2019
Tourist pensions	21,185	29,751	36,884	37,502	39,506
Agrotourism pensions	13,525	17,029	20,635	23,476	26,536
Total	34,710	46,780	57,519	60,978	66,042

Source: processing the field observations and data from National Institute of Statistics, 2021.

The highest value of the average dynamic rhythm is signaled at the agritourism pensions, which means an increase of the tourist segment towards this type of tourism. Values of the number of tourists according to the linear trend for the period 2015-2019 are increasing for both types of tourist and agrotourism pensions, which means an increase in the quality of services (Table 7).

In order to increase the number of tourists in pensions with a high degree of comfort, an orientation towards the total quality is needed, which must also take into account the quality of life and interpersonal relationships. Therefore, total quality management provides a broad framework for action leading to a process of continuous improvement by extending quality requirements, from products to processes, and further in relationships, attitudes and beliefs that it leads to success.

our results proved that in order to face much better to the market competitiveness and pressure, the administrators of tourist and agritourism guesthouses look to be more and more interested in constantly monitoring the needs of tourists in order to fully effectively cover their needs.

The methodical aspects of TQM in rural tourism from the perspective of the two principles and to propose solutions that can contribute to ensuring the efficient functioning of rural tourism reception structures were researched in the rural tourism activity of Vâlcea County.

Following this, it was observed that the non-existence of a complete inventory of tourist resources in the study region hinders the development of tourism. The tourist products developed in the study region capitalize only a part of the existing resources. The tourist offer of the county is reduced compared to other tourist regions in Romania. In addition, a number of resources that, through tourism capitalization, could attract tourists to the area and represent a source of income, are degrading due to the lack of capitalization initiatives. The absence of a system of observation of tourists visiting the study region does not allow the realization of a tourism development strategy adapted to the territorial reality. The tourism development strategies of the cities and communes in the region are based on theoretical results, observed at national and global level, rather than on data reviewed at territorial level related to the movement of tourists and their practices.

CONCLUSIONS

The analysis of rural tourism in Vâlcea County and the calculation of the indicators specific to rural tourism in terms of quality based on the principle of total quality management were "argued with data", and highlighted the aspects of rural tourism in close relationship with the managerial aspects based on "total quality management" focused on "customer orientation". Also, a theoretical-practical tool was developed to boost the approach to quality management, to increase economic efficiency and ensure a stable development of rural tourism in Valcea County, which consisted in calculating indicators for the quality of rural tourism in Valcea County and their importance in the implementation of pensions, by comfort categories.

From the data analyzed in the paper, it was concluded that more than half of the existing communes in Vâlcea County have tourist potential, presenting a significant degree of tourist attractiveness. The analysis of the evolution of the indicators - number of classified rural tourist pensions, existing accommodation capacity, number of arrivals and number of overnight stays registered in Vâlcea County, in the period 2015-2019, highlights their clear growth trend. The most significant increase of the indicators mentioned above is noticeable in the pensions classified at 2 daisies/stars, so in a lower category of comfort, for the whole period 2015-2019, because they address a segment of tourists with a low level of pretensions, but who know well the importance of the quality/ price ratio.

The analysis made on the tourist demand in the area showed that the highest demand was registered at the tourist structures rated with 2 daisies/stars, the attraction towards nature and the unchanged environment being the main motivation for tourists. In the studied area it was also observed that the average length of stay is short, and the low values of the indices of use of accommodation capacity in operation indicate a low efficiency, especially in 2018.

The low efficiency is mainly due to the short length of stay, only 3 days, a phenomenon manifested due to the lack, for most pensions, of leisure and recreation programs, complementary to accommodation services and dining. Of all the rural pensions in the county, the highest annual growth rate of the total number of tourists was registered at the 3 daisies / stars level, and the number of tourists according to the linear trend for the period 2018-2019 increased the most at the 2 and 3 daisies/stars pensions, indicators that reflected the trend of preferences for a tourist consumption based on the practice of a quality management is in a continuous progress.

The main directions for the development of rural tourism in Vâlcea County will have to aim at increasing the quality of tourist services, diversifying the tourist offer and more aggressive promotion of the county as a tourist destination. This involves investments for the development of human resources and the level of tourist service in boarding houses.

Those who work in county rural tourism have very little information about quality management in general and total quality management in particular. The implementation of the total quality management proposed in this paper must lead to a remodeling of the structure of existing and new accommodation capacities, according to the requirements of tourists, with great adaptability to the purchasing power of the population. The continuous improvement of the quality of rural tourism products and services, by implementing the principles of total quality management, would determine all tourist reception structures to give more importance to customer expectations, which will increase their competitiveness in the domestic and foreign tourism market.

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STUDY ON THE DEVELOPMENT OF A GIS FOR IMPROVING THE MANAGEMENT OF WATER NETWORK FOR AN AGRICULTURAL COMPANY

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Abstract

This paper presents in a rigorous and practical manner the way of developing and implementing a GIS, in which surveyed data is processed and the final results that contribute to the analysis and solving issues that arise on a day, to day basis, in the uninterrupted process of using a drinking water supply network, in order to improve its efficiency and the quality of the services. Using GIS software, maps and other cartographic data can be introduced into the system. Afterwards, the data can be stored for long periods of time, accessed at any point and easily analysed. With the tools made available by the GIS software, the datasets can be processed and new relevant information can be extracted which can be designed and printed as new maps. Such a system is truly a transformative ensemble of software because it has the power of changing the way decisions are made in a agricultural company, or anywhere in the world. In the field of hydraulics where it shall be used, it has been proven that the use of a GIS allows for a better and more detailed understanding of the water network and the way various network elements interact with each other. For an improved management of the water network, it is possible to also add to the database details regarding the quality and quantity of delivered water in a certain region. This makes merging all of the information in one system very important. All this precise information will improve the efficiency from a technical standpoint and also from an administrative one which will result in higher quality services for the customers

Key words: *water management, coordinates, database, GIS, inventory, map*

INTRODUCTION

As it is known, the GIS acronym – Geographical Information System, is frequently used in relation to computerised technologies whom are geographically oriented, integrated systems for various applications in the field and lately, for a new discipline that is generating worldwide a high degree of interest. Geographical information systems are often characterised by flexibility and diversity. GIS is an integrated system that brings together ideas developed in many fields such as: agriculture, botany, economics, mathematics, photogrammetry, zoology, geography, remote sensing and many others [4, 10].

Depending on the tasks that it needs to fulfil, there can be identified two types of information systems: 1. Transaction processing systems; 2. Decision support systems.

In the transaction processing systems, the accent is put on the recording and management of new operations. Banking transactions and plane ticket reservations are two ideal examples. These systems no matter if they work online or in a batch data processing mode can be oriented towards interrogating and refreshing data and there are some very well defined procedures [7].

In the decision support systems, the accent is put on processing, analysis and data modelling with the sole purpose of aiding decision-making. In a GIS, the reality is represented with the help of well defined graphical elements that can be put into two categories. Geographical data is used with the purpose of defining a position for the statistical data, such as administrative boundaries, a network of rivers or the coordinates of a point on top of a hill [1].

In a GIS, the geographical component is considered to be more important that the statistical one, and this is one of the main differentiating factors that sets it apart from other information systems. The terms “spatial” and “geographical” are often used interchangeably to describe geographical elements. The term “spatial” refers to any kind of information that can be tied to a particular location and it can include data gathered via remote sensing or topographical survey. The term “geographical” refers only to information regarding the position on the surface of the Earth or in its immediate vicinity [14].

The relationship between GIS, CAD, computerised cartography, database management and remote sensing is important for establishing a definition for GIS. It is sometimes considered that a GIS is a subset or a superset of the aforementioned systems. Not all programs that are capable to graphically represent a series of geographical elements can be considered a GIS [18].

Computerised cartographic systems are focused on interrogating and extracting data, classification and automatic symbology allocation. The focus is on graphically representing elements and not on using them in an analysis. These systems use simple data structures [22]. These can be correlated with database management systems but only basic database interrogation operations can be made. Computerised cartographic systems benefit from an array of tools with whom high quality vector maps can be designed and rendered [19].

Various notions regarding the geographical system can be reduced to just three components: the map, the database and the spatial analysis tools. The evolution of a GIS can be described as a process that contains three phases. The systems that are in the initial development phase are strongly oriented towards collecting and managing the data inventory. After three to five years, the focus shifts towards analysis operations. Most of the systems reach maturity after another 3-5 years and only afterwards can be considered to be decision support systems. Only in this final phase the spatial analysis operations and modelling start being routine [8].

According to ESRI, a GIS is a framework for collecting, managing and analysing data. Rooted in geography, GIS has the capacity to integrate an array of data. It analyses positions and organises multiple layers of information that can be visualized and represented with the help of maps and 3D modelling. With these unique abilities, GIS has the capacity to discover the relationship between data such as patterns and situations, helping its users to make wiser decisions [6].

MATERIALS AND METHODS

In this paper are presented fundamental elements of a GIS, the topographical and geodesic notions necessary, the implementation and development of a GIS in the field of water collection and distribution and the way in which it incorporates a vast array of data and information, how it stores it, analyses it and renders plans, maps and spatial analyses that assist in decision making, water network development and quality increase of rendered services.

Full implementation requires careful planning and management. Good knowledge and understanding of each of the system’s components is critical for planning the development and implementation strategy. Organisational GIS include the integration of a wide spectrum of technologies. There is a wide array of hardware manufacturers and solutions for network storage, database servers, Web servers, geographical data visualisation servers and desktops, all connected into various configurations either in local networks or straight to the internet. All these technologies must be able to function with one another in order to maintain a balanced processing environment [5, 21].

Centralised systems with a single database are the easiest to implement and maintain. Obviously, the ones with multiple databases are more difficult to implement and maintain. Because of this fact, many small and medium sized organisations decide to choose the former option, such as the one that was implemented in this study, for whom the risks of failure are smaller [23].

There are many opinions, steps and strategies for implementing an IT project and for the development of a GIS, but in this study were used the following guiding strategic initiatives:

1. Developing and implementing a strategy – A strategic plan is the guide that must be followed through in order to establish what is the initial vision, the objectives, requirements and other parameters associated with the implementation of a organisational GIS [16, 21].

2. Initiating a pilot phase – Considering the investment required for an organisational GIS and the extended period of time associated with full implementation, a pilot phase is an excellent opportunity for producing tangible results and for improving the project's support [15].

3. Establishing the hardware architecture and the software environment – The foundation of a GIS is given by the design of the hardware structure and the suite of software that need to produce the necessary results for the first phase. This will be different from one company to another because of the different requirements and needs [13, 21].

4. The development of a basemap – The main layer on which the system is built is the map of the area in which it needs to perform spatial analyses. The equipment used for field surveys is the Global Navigation Satellite System (GNSS) Leica Viva GS08 + CS10. Building a database can easily become the most costly aspect of the project development [17]. At the same time, it might be the one which is going to consume the most time. In this phase is necessary a careful analysis of the objectives that need to be reached and prioritize the ones that are vital for the well being of the department [2].

5. Developing standards and procedures – A GIS is more than just software, hardware and data. It needs to include procedures and standards that allow data and other technological components of the system to function consistently and efficiently [12].

6. Online visualization – In order to ensure an efficient integration with other departments that do not benefit from specialized IT hardware, it is necessary to develop a method of distributing GIS generated content in a seamless way. When the system becomes more widely-spread, such a visualization method becomes mandatory [9, 21].

7. Priority development/integration of applications – The system will need an environment which will allow it to be changed and updated in the future, as the various subsystems will need to be improved or replaced. This environment needs to be as flexible and as economically efficient as possible. These aspects need to be taken into account since the first phase of implementation. All systems that reach maturity will sooner or later require updates and modifications [20].

8. Developing an employee training schedule – As the system develops and is being adopted by more and more departments, the project manager must take into account the fact that not all of its users may have the required knowledge for interacting with it [19]. Because of this a training programme must be developed for the users so that all the information is being understood and its intensity must be adapted in such a way that the programme will be adapted to how each employee is going to interact with the system and its various GIS components [3, 21].

9. Project maturity – In an organisational environment, a GIS can not be implemented and afterwards left without a leader, coordination, support and room for growth. A department management system will have to be developed in such a way that operational efficiency, value and longevity will be guaranteed [11, 21].

RESULTS AND DISCUSSIONS

Developing a GIS for a company means developing a series of applications and tools that offer a complete solution starting with collecting data, continuing with processing it and finally sending the deliverables to the interested departments. A fairly new strategy is making available all of the geographical data to all of the departments, in such a way that the whole company is helped, satisfying the individual needs of each department. The advantages of such a setup consists of reduced information redundancy, improving data accuracy and integrity and the efficient sharing and use. Since the data is the most valuable investment for a GIS, any approach that reduces acquisition costs while maintaining quality is important. Implementing a GIS can bring IT maintenance cost reduction. This way, the efficiency with which data is used and handled inside the organisation is increased and it covers the needs of all of the departments common standards, procedures and methodologies. For a company the advantages that a GIS brings can be translated into increased operational efficiency, the ability to integrate the geographical data into adjacent systems, workflow efficiency, accuracy, safety and improved data integrity, improved coordination amongst the departments, improved sharing procedures of data and improved system management.

This study is oriented towards a company, SC Avicarrvil SA, located in the Valcea county that next to its agricultural activities, also processes meat and produces fodder, which makes its water usage to be fairly high. Because of this, the need to implement a GIS that will manage and observe the use of water was highly needed. For the implementation of the GIS, the following steps were taken:

Planning the field survey with the GNSS instrument.

Field surveys using the Global Navigation Satellite System technology have become common for a wide variety of situations. The positional accuracy is strongly influenced both by the number of satellites available at any time and their relative position on the sky. Theoretically, satellite constellations are designed in such a way that at all times there will be at least four satellites available anywhere on the planet. The presence of natural or artificial obstacles and unfavourable meteorological events, reduce the visibility and the accuracy with which the positioning is made. Taking into account that there are available multiple satellite constellations and that the instrument that is being used is one that supports a wide range of them, planning the survey is not a critical step but it is necessary for confirming that the chosen method to survey is correct. On 05.06.2021 the maximum temperature was 23°C and the minimum temperature was 7°C. During the day the sky was covered in clouds only between 08:00 PM to 10:30 PM. There was no rain (Figure 1).

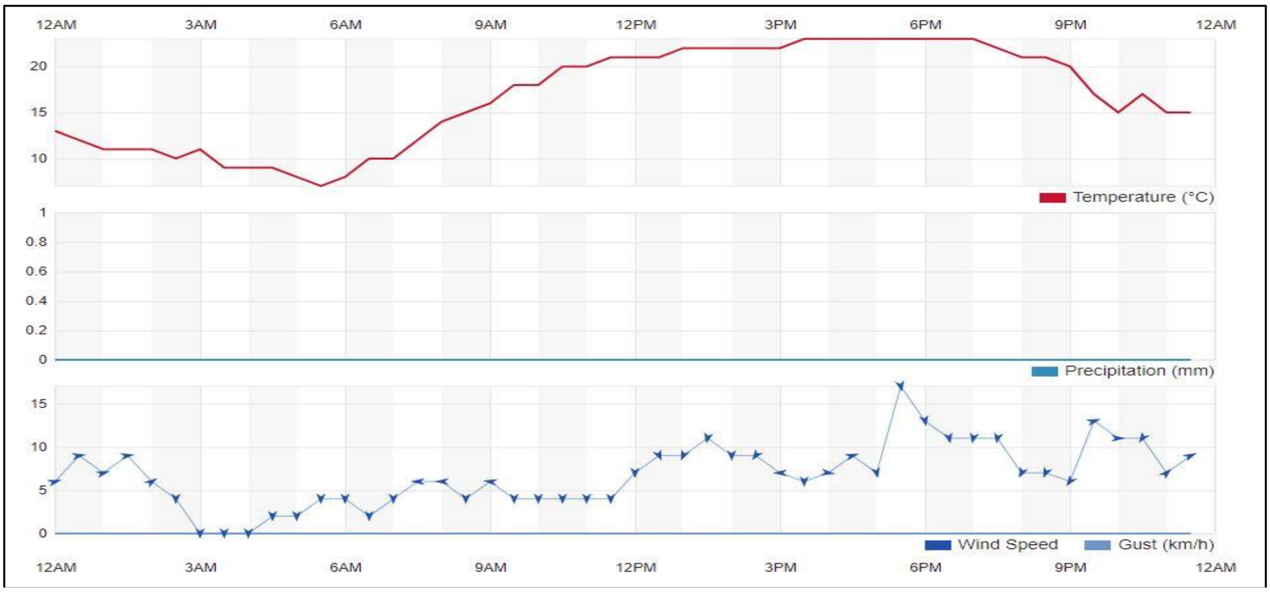

Fig. 1. Meteorological overview: Temperature (ºC) and Precipitations (mm), on June 5th, 2021.
Source: own field observations.

Considering that the meteorological conditions are good, the next step is determining the ideal time of day for the surveyed location, for having access to as many satellites as possible from the GPS-NAVSTAR, GLONASS and Galileo constellations (Figure 2).

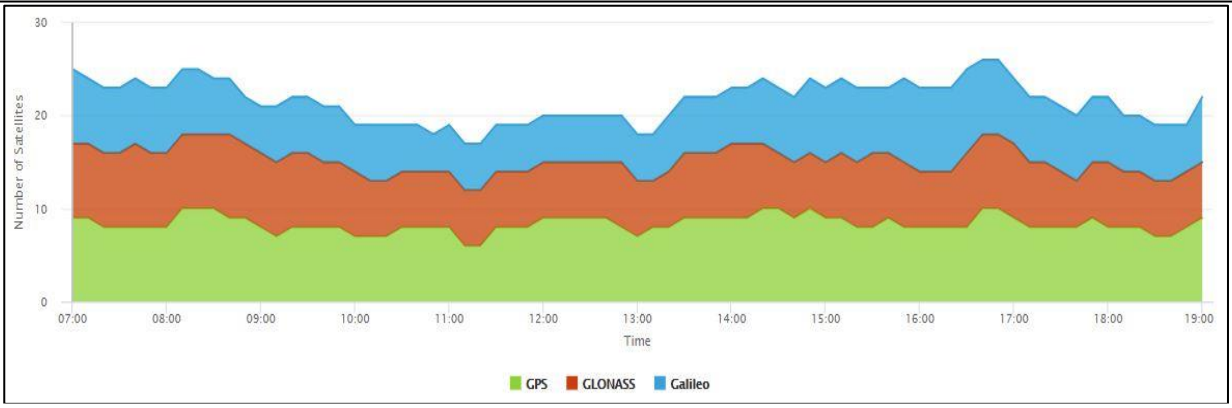

Fig. 2. Elevation (GPS-NAVSTAR, GLONASS, Galileo)
Source: own field observations.

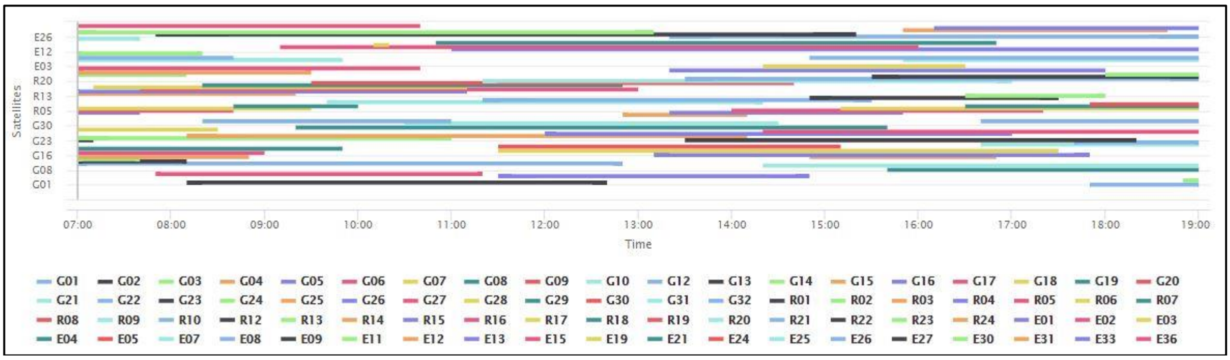

Fig. 3. Number of visible satellites
Source: own field observations.

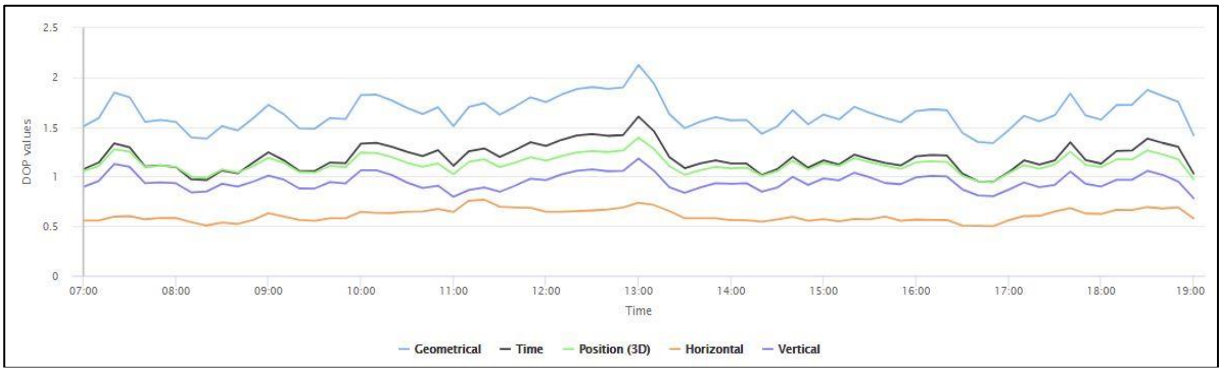

Fig. 4. Visibility period of the available satellites
Source: own field observations.

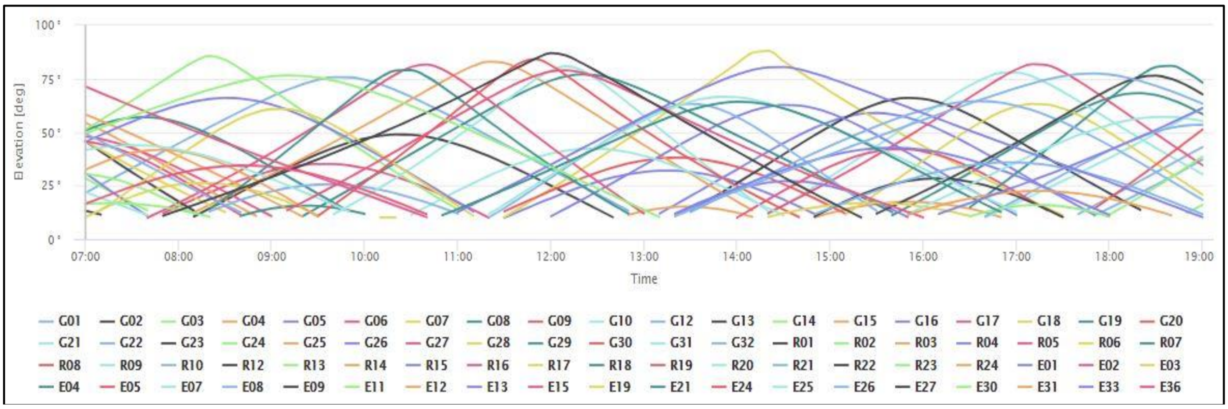

Fig. 5. Geometric dispersion of precision (DOP Values);
Source: own field observations.

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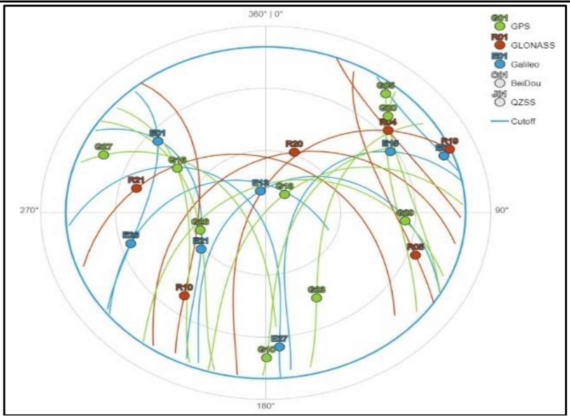

Fig. 6. Skyplot – Cutoff 10° (15:00 PM – 05.06.2021)
Source: own field observations.

The Figures 2, 3, 4, 5 and 6 above were created using the Trimble Global Navigation Satellite System (GNSS) Planning Online website, Trimble Inc., Ver. 1.5.0.0, accessed 05.06.2021 [24]. The graphs represent the position and constellation status in the day chosen for the field survey for the subject of this paper.

Initializing, configuring and performing the field survey

The field survey of the study area consists of assembling the GPS Rover, connecting it to the internet for the RTK communications, creating a working job, setting its parameters, establishing the coordinate system and finally performing the survey.

Photo 1. The contents of the Leica transport box
Source: own field observations.

A. **Assembly** The two main components of the Leica instrument – the controller and the GNSS antenna – are located in the transport box next to additional accessories. The GLS13 aluminium pole is also required for connecting the two (Photo 1).

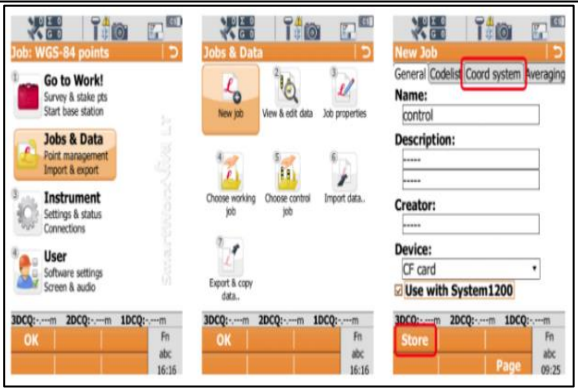

Fig. 7. Creating a control job
Source: own field observations.

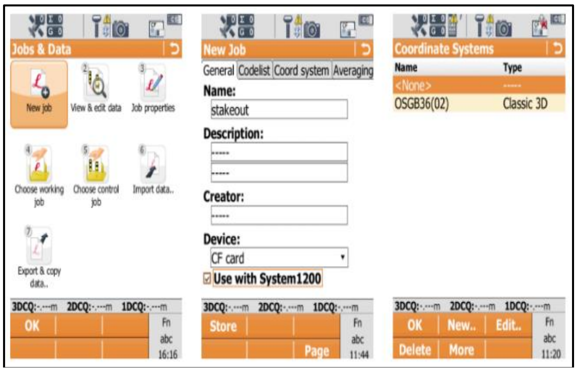

Fig. 8. Adding points into the control job
Source: own field observations.

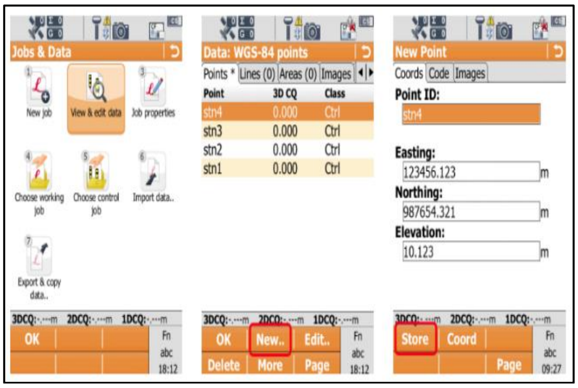

Fig. 9. Creating a stakeout job
Source: own field observations.

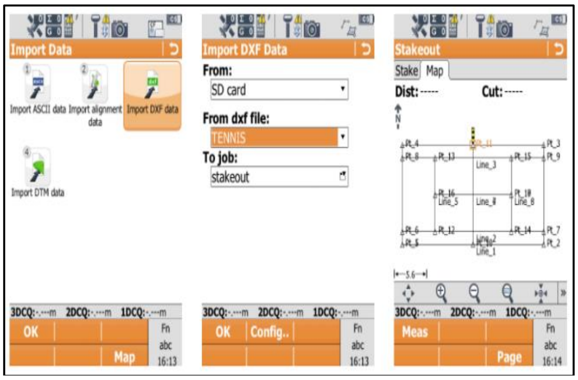

Fig. 10. Importing a DXF file into the stakeout job
Source: own field observations.

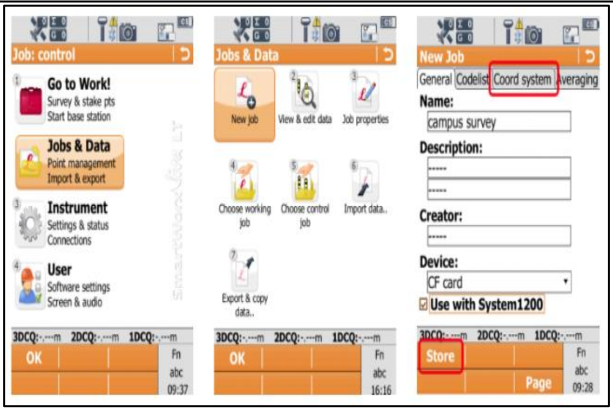

Fig. 11. The stakeout procedure
Source: own field observations.

Creating a control job

After setting the set to a so-called "SmartRover" configuration, the controller and antenna were turned on using the power buttons. The controller will boot-up Windows, from which you can double-click on the SmartWorx Viva Lite icon from the desktop. The main menu will be shown which contains 4 icons: “Go to work!”, “Jobs & Data”, “Instrument” and “User” (Figure 7).
For creating a control job Tap ‘Jobs & Data‘, ‘New job‘, and create a job called ‘control’, storing the data to CF-Card or Internal Memory. To add text, use the pop-up touch-screen keyboard, pressing RETURN to store the text. The ‘Coordinate system‘ (the 3rd tab) should be changed to ‘None‘. It will be configured later. When finished, tap ‘Store‘. This will return you to the main menu.

Adding points to the control job

From the main menu, tap “Jobs & Data”, then “View & edit data” and “New.” to add the known control points. After point names and coordinates are typed in, click on “Save” (Figure 8).

Creating a stakeout job

A stakeout job has the purpose of storing known coordinates of points that are not materialised in the field and to determine their position. For example, it can store point coordinates for a future property boundary that can afterwards be marked. From the main menu click on “Jobs & Data” and set a name. In the “Coord System” section Stereo 70 coordinate system is chosen. This is the one used in Romania. After setting a name, click on “Store” (Figure 9).
After creating the job, the name and the coordinates of the points are added using the same steps as mentioned earlier. In order to be considered control points, names and coordinates must be added manually or imported via Comma Separated Values (CSV) files. It is also possible to add CAD drawings such as DXF files (Figure 10).

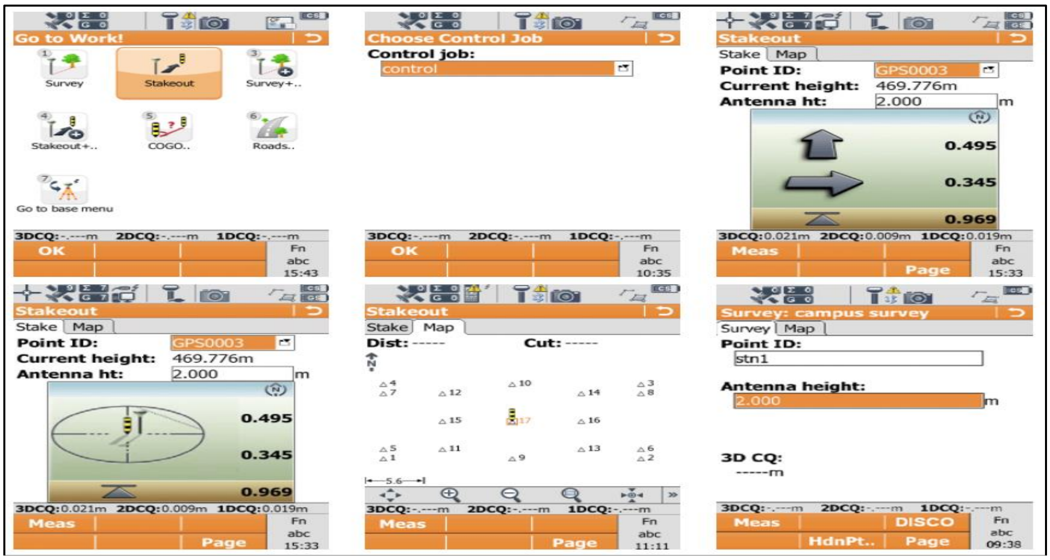

Fig. 12. Creating a working job
Source: own field observations.

After the correct import of the points that need to be marked in the field, click on “Go to Work!”, then “Stakeout” and in the menu the file that contains the control jobs needs to be selected. One of the points will be chosen from the list and the controller interface will turn into a 3D target that aims to get the user as close as possible to the coordinates of the chosen point. After it has been identified, using the navigation arrows, the user can switch to another point (Figure 11).

This was necessary because in the study area there are a few elements whose position needed to be verified. It is about the safety boundaries of a micro-treatment plant and a water reservoir for whom fences were built. After the fast verification of their position, we move on to creating the working job which will store the objects resulted in the field survey necessary for the study.

Creating a working job for the field survey

For the field survey a working job is necessary which will contain all of the new coordinates that will be surveyed. Just like in the previous steps, click on “Jobs & Data”, then “New job” and set an easy to identify file name. Different from the previous steps, this time we will define the coordinate reference system. In Romania, it is used the ETransDatRO option which allows for on-the-fly transformation of surveyed coordinates into Stereo 70 (Figure 12).

After the field survey was completed, there were 92 points that were identified and surveyed. They represent various elements of the water and sewer network. X and Y coordinates can be found in Table 1 shown below. The topographical survey represents the first and easiest step of the whole process of collecting, processing and visualising the data but it is also the one that defines the level of quality and precision for the rest of the work.

It is the operator’s job to collect all of the relevant information as detailed and as precise as possible. Usually, for each point, there are a series of notes and drawings. This is especially necessary for the sewer network. Just an identification code and a limited number of characters are not enough to provide all of the required information that can be identified in the field.

Each sewer manhole comes with a lot of details that have an impact on the way the entire network runs, starting from the ones that can be observed from the street level such as the manhole status, the locking ring and continuing with a detailed sketch that will contain all of the measurements that define that particular sewer network element. In a GIS, no matter how technologically advanced it is, if the data that is being input is wrong, the results from all of the spatial analyses will be wrong. The quality standard always needs to be maintained and fulfilled.

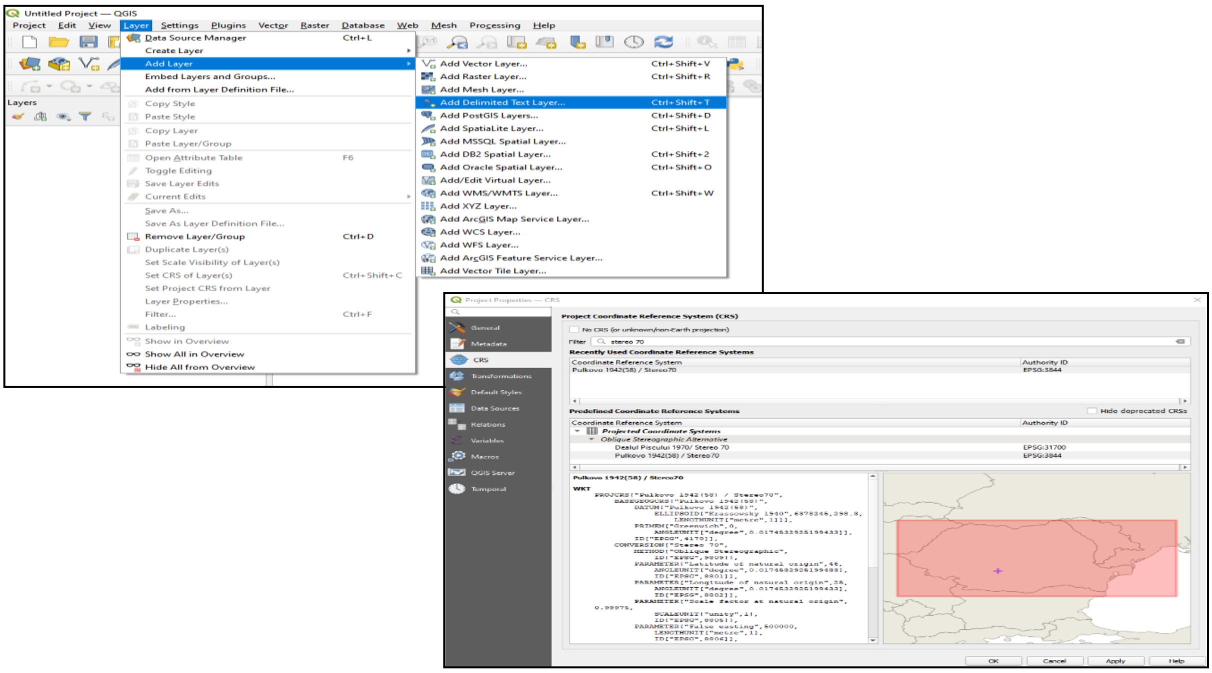

Fig. 13. Importing the Comma Separated Values (CSV) file and defining the coordinate reference system;
Source: own field observations.

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Table 1. Coordinates X and Y of the surveyed elements

Nr. Point	X (m)	Y (m)	Nr. Point	X(m)	Y(m)	Nr. Point	X(m)	Y(m)
0	443175.439	394870.525	31	443178.752	394844.393	62	443095.472	394949.650
1	443059.107	394956.125	32	443114.837	394830.034	63	443140.013	394860.100
2	443139.878	395012.018	33	443084.469	394887.830	64	443117.935	394848.374
3	443096.442	394975.569	34	443138.915	394919.103	65	443182.755	394873.723
4	443130.593	394995.666	35	443189.731	394947.163	66	443176.636	394931.990
5	443080.077	394975.730	36	443156.825	395002.098	67	443169.529	394928.324
6	443195.044	394890.685	37	443104.665	394973.059	68	443100.364	394964.902
7	443043.725	394996.021	38	443051.933	394944.253	69	443169.864	394944.356
8	443062.648	395005.012	39	443036.136	395010.233	70	443115.295	394915.309
9	443077.536	395013.557	40	443069.534	395029.124	71	443269.116	394818.045
10	443082.037	394901.050	41	443124.205	395060.007	72	443227.267	394873.609
11	443154.913	394985.839	42	443054.120	395020.660	73	443216.427	394891.350
12	443150.711	394939.877	43	443174.117	394869.798	74	443057.782	394952.060
13	443134.943	394906.007	44	443058.766	394954.656	75	443260.882	394816.863
14	443097.418	394888.171	45	443196.460	394891.508	76	443120.086	395059.828
15	443065.360	394944.597	46	443082.686	394899.938	77	443015.397	395001.209
16	443138.129	394983.286	47	443080.894	394973.841	78	443152.638	395001.916
17	443130.097	394929.670	48	443129.173	394995.829	79	443048.576	394944.490
18	443123.654	394893.760	49	443139.793	395010.497	80	443114.434	394831.365
19	443094.082	394948.842	50	443076.957	395014.598	81	443232.073	394844.005
20	443119.573	394846.582	51	443061.921	395006.554	82	443236.021	394847.552
21	443139.289	394861.331	52	443043.215	394997.225	83	443236.785	394846.169
22	443180.753	394874.262	53	443094.806	394976.167	84	443231.462	394878.921
23	443177.870	394932.582	54	443153.899	394985.209	85	443260.878	394816.862
24	443167.104	394927.782	55	443151.662	394940.435	86	443120.016	395059.788
25	443101.745	394965.549	56	443136.426	394906.655	87	443015.663	395001.334
26	443170.688	394944.764	57	443098.623	394889.051	88	443048.433	394944.416
27	443116.204	394915.903	58	443064.294	394943.810	89	443152.475	395001.826
28	443260.678	394817.205	59	443136.870	394982.307	90	443114.281	394831.281
29	443224.035	394889.992	60	443129.106	394929.072	91	443231.351	394878.717
30	443171.589	394860.480	61	443122.713	394893.362			

Source: own field observations.

Processing the data from the field survey

The data was downloaded from the GNSS Rover as a Comma Separated Values (CSV) text document and it was imported into Quantum Geographic Information System (QGIS) 3.16 "Hannover". A CSV document is a text file that defines a table by using a comma or other symbols as a separator between cells. The document's rows, define the table's rows.

In this study, the table will have four columns separated by commas and on the following rows it will contain the "Point ID", "X", "Y" and "Z". Additionally, it might contain the column "Description" (Figure 13).

Although this type of file can store complex tables for a low storage value, for Quantum Geographic Information System (QGIS) is not that helpful because it does not contain important information regarding the coordinate reference system.

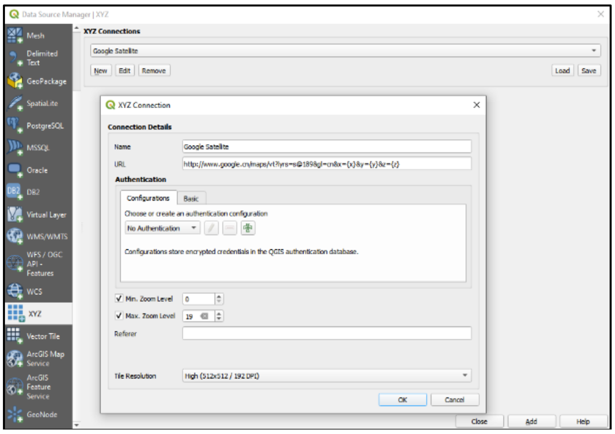

Fig. 14. Importing the Google Satellite orthophoto map
Source: own field observations.

The first thing needed to be done is to define the CRS. At the moment of import, the application will ask if the first row of the document represents the heads of the columns, which symbol defines the cell end, which are the columns that define the X and Y axis, if there is also a column that contains Z values and what is the coordinate system that will be used for the project. In this case, the CRS used is EPSG 3844 – Pulkovo 1942 (58)/ Stereo 70.

Following all of this, it is necessary to import an orthophoto map that will be used as a basemap for the elements that were surveyed. On top of it, it will be added the layer that contains polylines with transparent symbology but will have labels with the names of the streets inside and around the study area. The XYZ Tile Server service is an efficient and fast solution for this and it also has a high enough resolution for this project. Quantum Geographic Information System (QGIS) downloads from the Google servers orthophoto map tiles with a resolution of 256x256 pixels. The main advantage is that the computer does not need to download the whole raster like in the case of using a TIFF file. Quantum Geographic Information System (QGIS) will interrogate the Google server and download only the sections that are included in the workspace extent (Figure 14).

Photo 2. Adding details from the GIS interface
Source: own field observations.

When the user changes the workspace extents by zooming or panning, the program will load new tiles while the ones that might not be visible anymore will be stored in a cache for future use.

Most of these services follow the Google Maps standards: Tiles have a 256x256 resolution; Zoom level 0 allows for the rendering of the whole world; Each level of zoom will divide the old tile into four new tiles; 22 zoom levels are available and it is enough for most applications; The service uses the WGS 84/Pseudo-Mercator projection which at the moment is the standard in industry, after it was adopted by Google Maps in 2005.

In simple terms, the coordinates X, Y, Z Tile Server service downloads a series of aerial photographs that have been georeferenced and ready to use. If the project's requirements are not met by this service there is always the possibility of contacting a company that has the tools and knowledge to provide aerial photographs that meet the requirements. In this case, the coordinates X, Y, Z Tile Server provides good enough data. From previous field surveys and employee knowledge, the GIS department already had information regarding the sewer and water networks of the study area but the level of precision required was not met.

Taking into account the fact that one of this GIS' objectives is to create a precise hydraulic model of the study area, the level of detail obtained from digitizing and other sources is not high enough. Eventually, all of the elements that belong to the water and sewer network will need to be repositioned with the help of precise topographical instruments. The GIS server stores geographical information that can be divided into three categories: "water network", "sewer network" and "topographical data".

The following steps towards completing the map and presenting the gathered information consists of importing SHP files that contain property boundaries, buildings, electricity and lighting poles, land use information and postal numbers (Photo 2).

The implementation of a GIS in the studied agricultural society, SC Avicarvil SA, Valcea County dealing with agricultural activities for producing fodder for poultry and poultry raising for meat production, processing and delivery, process which need a high amount of water, will lead to significant results. Below are all the final benefits that GIS has to offer:

1. Basemap/Data model – that contain the geometry and element attributes with a general level of information such as streets, property boundaries, buildings, land use, lighting and electricity posts, parking lots and many more. The map on which various spatial

analyses will be performed, it needs to have the highest level of geometric accuracy and quality of statistical data.

2. Software/Hardware – It is anticipated that a suite of software and hardware components will be needed for the successful implementation of the GIS. Where gaps are found, new software should be added. Also, it is necessary, in the majority of the situations, acquiring a data storage and sharing system – a server.

3. Online preview – One of the most important components of the system is the module capable of sending geographical data to a portal where visualising and interrogating data is available through an internet connection.

4. Standards/procedures – Promoting and adopting standards company-wide will insure system consistency, reliability and quality. Most often, the types of standards and procedures refer to the way of metadata manipulation.

5. Software development capacity – It will not be possible to satisfy all company requirements with just the help of commercial software. Because of this, it is necessary to introduce an environment in which software adaptation is possible and standardized.

6. GIS organisational programme – After the final implementation phase, the GIS needs to transform into an organisational programme. It will help promoting and coordinating GIS technologies especially during those projects that are critical for the improvement of financial processes and available services. Also, the programme will help tangent departments with standards, training, GIS technologies and improved performance.

From an economic point of view, the application of GIS in the agricultural society has led to the saving of a significant amount of clean water, used in meat processing and feed preparation processes. This was mainly possible due to the rapid ability to identify and manage all faults and breakdowns in the water distribution network. In meat processing and feed preparation centers, everything starts with water, it is used for watering and washing animals, washing trucks, washing carcasses and by-products, as well as for cleaning and sterilizing equipment and processing areas. Water consumption rates can vary considerably depending on the scale of the technologies, their age and type of processing, the level of automation and cleaning practices. Typical figures for fresh water consumption are 2-15 m^3, per tonne of live carcass weight. In most parts of the world, the cost of water is rising as the supply of fresh water becomes increasingly difficult, taking into account the real environmental costs. Water is thus becoming an increasingly valuable resource, and its efficient use is becoming increasingly important. Strategies to reduce water consumption may involve technological solutions or equipment upgrades. From the estimates made by the beneficiary it was concluded that, by implementing this system, the average daily water consumption was reduced by over 75 m^3. This means a saving of clean water of over 1,575 m^3 per month, which brings a net income of over 9,450 lei per month, and annually brings an income of over 113,400 lei, an amount that could be used in other sectors to modernize production processes. The reduction was mainly due to the total automation of water distribution processes, based on the data included in the GIS and the precise thematic maps prepared.

CONCLUSIONS

In conclusion, the study has lead to completing all of the proposed objectives such as: identifying and moving through the phases of planning, developing and implementing a GIS that has the purpose of storing, processing and presenting all of the topographical data that is in use by an agricultural company.

By implementing this GIS all the following risks have been removed:

-Conversion costs of existing data – Generally, geographical data collection and conversion are the most expensive activities. Since the beginning of the planning phase, the estimations for these steps were made as accurate as possible. A detailed evaluation of the needs for the data collection and conversion period can offer a detailed overview for this phase.

-Departmental conflicts – Taking into account that an organisation-wide GIS is developed with the purpose of serving the majority of the departments through an integrated system, inevitably there will be contradictory opinions about how it should be managed. While this in inevitable in multi-departmental environments, during the GIS implementation, it was very important to achieve the objectives that were set. Communication and development procedures were implemented in order to not have delays and supplementary costs or situations in which the project is not ready for certain activities.

-Continuous support and coordination requirements – A GIS will not survive and offer reliability as long as it is not managed, coordinated and maintained by the staff. The entire technological framework is an expensive one and for the long term it can reduce costs associated with many activities but this is impossible without a dedicated team that is willing to achieve the objectives in an efficient manner.

-Complex technology – Although the front-end GIS has become a lot simpler and accessible for the average user, it is still important to take into account the fact that the technology and the processing algorithms that run in the background of GIS applications are more and more advanced as time passes. This aspect must not be ignored. If the required abilities are not available then all of the benefits that a GIS promises will not be accessible which is why our study company needs to benefit from teams that will be dedicated to the maintenance and implementation processes.

Because of the implementation of such a system, many advantages were obtained: It has become an important component in the information flow of the company with the help of its processing and visualisation abilities in an intuitive manner; Making use of all of the geographical data that is offered towards all of the employees no matter how good their desktop may be; Reduced reaction times no matter the issue that arises because the access to correct information is done in an easy to understand manner and planning for a solution can be done in an efficient way.

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RESEARCH ON ATTITUDE AND THE BEHAVIOR OF THE ROMANIAN YOUNG GENERATION IN RELATION TO THE PURCHASE AND CONSUMPTION OF ORGANIC PRODUCTS

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Abstract

The paper aimed to study the purchase habits and behavior of the young generation regarding consumption of organic products. For this purpose, literature in the field was studied regarding the EU organic production and consumption. In order to determine the young Romanian consumers' perception concerning the organic products, a field survey based on a questionnaire was run during March -June 2021 on a sample consisting of 191 students from Sibiu and Brăila. Organic agriculture is a dynamic system in Romania, registering in the last 10 years an ascending trend, from 182,706 ha in 2010 to 468,887.05 ha in 2020. The organic products are consumed by the 90.6 % of the young people investigated (173 persons). They purchased organic products mainly form local markets (81.15%), super (80 %) or hypemarket (70.1%). Also, an amount of 66 % respondents use to buy organic products from specialised stories. The young generation believes that the most effective way to promote the consumption of organic products are: events organised in hyper or supermarket, specialised fairs for organic products, events like"open doors" at ecological operators. The students who were part of the target group of this study are in the category of well-informed consumers. They know how to recognize organic products by the existing marks on the packaging (69.6%). Young people say the main qualities of organic products are: healthy (93.2%), tasty (71.2%), contain fewer chemicals (61.8%), improve quality of life (51.3%), do not contain synthetic additives (48.7%). At the same time, organic products protect the environment (45%), support family farming (40.3%) and the local economy (40.3 %).

Key words**:** *knowledge, buyers, behaviour, consumption, organic products*

INTRODUCTION

The sustainability of food production systems is a global challenge. Even with lower average yields, organic farming and sustainable animal husbandry can offer alternative solutions to conventionally obtained products [3].
Organic farming is practiced worldwide on approx. 13,095,756 ha, and in Europe on 16,528,677 ha Aand has continuosly an increasing trend [17, 28].
More than 200 countries worldwide practice this system of agriculture [9].
The organic production system seeks to strike a balance between the three areas of agricultural sustainability: environmental, economic and social [29].
The Community's agricultural policy pays special attention to organic farming, considering that it must be increasingly promoted in order for the organic food market to grow. Thus, the main objective is that by 2030 more than 25% of EU agricultural land will be worked in an ecological system. Organic farming helps maintain biodiversity, creates jobs and attracts young farmers [14].
EU action plan on expanding organic farming in Member States is in synergy with the European Green Pact, Biodiversity Conservation Strategy and Fork Farm Strategy [12, 14].
All these strategic documents provide for urgent measures aimed at bringing improvements and transformations to the food system.

In the current period traversed by the Covid 19 pandemic crisis, the need for changes in farming and animal husbandry practices, for the increase of organic farming systems or alternative production systems is becoming increasingly evident. Changes are also needed in food distribution, with increasing importance for local producers and short food chains [18].

In 2019, Austria had 24.1% of the agricultural land certified in ecological system. Four EU Member States: Spain (2,354,916 ha), France (2,240,797 ha), Italy (1,993,225 ha) and Germany (1,613,785 ha) owned more than 57% of the total EU certified organic area [11, 17].In the same year, 2019, at the U.E. level. the land area in ecological system was 14.6 million ha, representing approx. 8.5% of the total agricultural area [17] Sweden is the country with the largest area of cereals and vegetables in the organic system, and Greece the country with the largest number of cattle in this system [15, 16].

Starting from the current growth rate of organic farming, the forecasts predict the expansion of organic land in the EU. up to approx. 15-18%. In order to reach the target of 25% organic agricultural area in the EU, the inclusion in the CAP 2023-2027 of eco-schemes that benefit organic operators is envisaged. The main tools that can support the increase of ecological areas are: the organization of promotion events, the creation of cooperation networks, the exchange of good practices, research and innovation, local processing. Better collaboration between the agricultural and tourism sectors is also planned for the creation of "Biodistricts" in order to sustainably manage local resources [13].

Most published studies show that plant productions made in an ecological system are approx. 20% lower than in conventional agriculture [21].

Raising animals in an ecological system is based on the following principles: raising local, resistant breeds; the animals must be able to show the behavior characteristic of the species to which they belong; access to pasture; maintenance in free housing; optimal areas per animal in shelters; sanitary shelters; prevention of diseases and illnesses; banning antibiotics and growth regulators in animal feed.

There is a trend in research to find alternatives to the use of antibiotics. Thus, between a study on the treatment of mastitis in cows with alternative solutions, extracts of medicinal plants and propolis were used. According to the authors, such preparations are safe, cheap and effective solutions in treating these diseases [26].

The situation of organic agriculture in Romania

A study published in 2014 shows that the first association dedicated to organic farming in Romania appeared in 1997. The first law on organic farming appeared in Romania in 2000, and the first inspection and certification bodies were accredited since 2004.

In 2020, the ecologically certified land area in Romania reached an area of 468,887.05 ha (of which about 67% arable land), increasing by 256% compared to 2010 (182,706 ha) [8].

In the same time, the number of certified operators in organic farming increased from 3,155 in 2010 to 10,210 in 2020.

According to the data presented by Eurostat, the number of animals exploited in an ecological system in Romania in 2020 were: 19,870 head of cattle, of which 12,837 head of dairy cows; 13,189 heads of sheep; 830 heads of goats, 143,198 heads of laying hens; 27,045 broiler heads and 170,789 bee families [16].

An article published in 2021 confirms the upward trend of land areas in the ecological system and the number of ecological operators in Romania [1].

The data presented by the relevant ministry show that currently in Romania are accredited 11 inspection and certification bodies for organic farming [24].

In Romania, few studies have been done on organic farming and consumption of organic products [22].

Such study on organic farming in Romania in 2012 showed: 288,261 ha, 15,315 organic operators, 105 organic processors and 3 importers of organic products [5].

The evolution of food quality is dictated by consumer requirements [25].

The current study contributes to knowledge regarding the routines of younger generation in organic food consumption behaviour.

MATERIALS AND METHODS

The research is based on a deep documentation based on various reports provided by European Commision and published articles concerning the EU and Romanian organic production.

To know the habits of young consumers regarding the purchase and consumption of organic products, a survey was carried out, using as a working instrument a strutured questionnaire, including: the socio-demographic profile of the respondents; buying and consuming habits of organic products; the place of purchase of organic products and the frequency of purchase; sources of information on organic products.

The questionnaire was applied to individuals aged over 18 years old, and the tool used for collecting data was the structured questionnaire applied to a sample of 191 Romanian students (students at Agricultural Faculties from Sibiu, Bucharest and Brăila, Romania).

After setting up the questionnaire, the contact with the young individuals included in the sample was made through internet, the questionnaire being sent online, and completed during the period March - June 2021. The collected data were classified, then statistically processed, and interpreted.

The young persons included in the sample of respondents were obliged to characterize themselves regarding their socio-demographic profile: gender, age, stable domicile, last graduated education unit, job status, profession, number of family members and income/family.

RESULTS AND DISCUSSIONS

Till present, just a few studies were carried out both at the international level and in Romania regarding the behaviour of purchasing and consumption of organic products [32].

A study published in 2021 shows that Romanian education campaigns are needed to develop healthy eating habits and to make sustainable food choices [31].

Current patterns of food consumption are not sustainable, neither in terms of health nor in terms of the environment. In the current context of the Covid 19 pandemic, there are specific changes in food consumption behavior [20].

Some studies show that adopting a certain healthy style of eating is a matter of social, economic and environmental sustainability [23].

A study conducted in Switzerland segmented consumers based on eating habits in relation to environmentally friendly technologies used for production [19].

In Romania, in 2013, it is shown that the motivation of buyers of local/traditional and BIO products is difficult to observe and appreciate [30].

The first store with ecological products was opened in Sibiu in 2004. Within it, 15 farmers sold their agri-food products, the promotion being done through their own site from which there were links for the farmers' own sites [4, 7]. Some studies aimed to identify useful fauna from organically grown gardens in Sibiu County [2].

The socio-demographic profile of the respondents

Respondents structure by gender

Of the 191 individuals included in the survey, 59.2 % were females and 40.8 % were males (Table 1).

Respondents' distribution by age group

The main characteristics of the studied sample are: 62.8% are young people, under the age of 30 (120 persons).

Respondents' distribution by the domicile

the sample consited of 62.3% respondents living in the urban area and 37.7% in rural area.

Respondents' distribution by the number of persons in the family

A number of 143 respondents repreeznting 75% of the total had large families consisting of 3-5 or more than 5 people.

Respondents' structure by monthly income

The average monthly income of the family is: less than 2,000 lei (8.4%); between 2,001 and 6,000 lei 59.2 %; between 6,001-8,000 lei

17.3% and only for 15.2 of respondents the familiy income is more than 8,001 lei.

Respondents' structure by education level

About 39.3% of the respondents have at least a high school diploma, being currently undergraduate or master's degree students of an agricultural faculty (Table 1).

Table 1. Demographic profile of respondents

Variable	Operational variable	Respondents distribution, number (%)
Sex	Male	78 (40.8)
	Female	113 (59.2)
Age	Under 20	18 (9.4)
	21-30	102 (53.4)
	31-40	36 (18.8)
	41-50	26 (13.6)
	51-60	8 (4.2)
	Over 60	1 (0.5%)
Areas of living	Urban	119 (62.3)
	Rural	72 (37.7)
Net income/month/ Family	Under 2,000 lei	16 (8.4)
	2,001-4,000 lei	72 (37.7)
	4,001-6,000 lei	41 (21.5)
	6,001-8,000 lei	33 (17.3)
	More than 8,001 lei	29 (15.2)
Education level	Gymnasium	10 (5.2)
	High school	75 (39.3)
	University degree	82 (43.9)
	Post graduated	24 (12.6)
Labour market status	Pupil	14 (7.3)
	Student	58 (30.4)
	Employee	103 (53.9)
	Entrepreneur	12 (6.3)
	Unemployed	3 (1.6)
	Other	1(0.5)
Number of people in the household	1	12 (6.3)
	2	36 (18.8)
	3-4	115 (60.2)
	5 or more	28 (14.8)

Source: Own processed results based on respondents' answers, Survey, 2021.

Buying and consuming habits of organic products

90.6% of young people surveyed buy and consume organic products (173 people). In general, they do not give importance to the origin of organic products, but most of them , more exactly 51.3% declared that they prefer Romanian organic products. About 38.2% respondents buy both Romanian or other origin products. It is noted that approx. 10.5% of those surveyed do not pay attention to the origin of the organic products they buy. The majority of respondents (65.5%) have been buying and consuming organic products for more than 2 years (125 people), which shows that they know the quality of organic products and their benefits.

The diet of young respondents is generally based on meat products for 148 people (77.5%) and an ovo-lacto-vegetarian for 40 people (20.9%).

Frequency of purchasing organic products

The frequency of purchasing organic products is also quite varied. Thus, 41.4% (79 people) of the respondents usually buy fresh BIO products 1-2 times a week, and 28.8% buy this type of product once every two weeks (55 people). It is noted that 5.8% of respondents (11 people) buy this type of product once a month, and 22.5% of respondents buy organic products occasionally (43 people).

In a study published Bogza (2015), it is shown that depending on the level of knowledge about organic products, there are four categories: respondents who can not say anything about these products; respondents whose level of knowledge is difficult to determine; respondents who know what organic products are and very well informed respondents [6].

Young respondents, students of agricultural or food industry faculties recognize organic products according to the BIO specification on the packaging (69.6%), according to the leaf type design on the packaging (36.1%). There is also a percentage of 9.9% of respondents who do not know how to identify organic products according to the special marks on the packaging.

Extrapolating the answers received from the subjects in this study to the 4 types of consumers identified in the paper mentioned above, it is observed that the young people in this study are part of the category of very well informed respondents.

A study published in 2014 by a group of authors showed that Romanians have little knowledge about organic products. In the case of young students of some agricultural faculties this is not confirmed [10].

Frequency of consumption of organic products

The frequency of consumption of organic food varies by category. Thus, the main categories of organic food consumed regularly are: eggs (73 respondents), vegetables (69 respondents), honey and bee products (67 respondents) and fruits (61 respondents). The main organic foods often consumed are: fruits (61 respondents), vegetables (59 respondents), dairy and cheese (56 respondents), eggs (51 respondents), meat and butchery products (50 respondents) and honey and bee products (46 respondents).

Sources of supply of organic products

In general, organic products are purchased from local agri-food markets by 81.15% of respondents (155 people), from specialized supermarket districts by 80% of respondents (153 people), from hypermarkets by 70.1% of respondents (135 people) or from specialized stores for organic products by 65.96% of respondents (126 people). It is generally observed that the majority of buyers of organic products associate this production system with local products, encountered in producers' markets. It is noted that 81% of respondents stated that they are not used to order organic products online (155 people). Also, short supply chains that include orders for weekly shopping baskets are not well developed locally. A share of 81.6% of respondents (156 people) stated that they had not heard orders for weekly baskets of agri-food products coming directly from farmers. These answers allow us to say that organic products are insufficiently promoted through online platforms.

Elements that can influence the decision to buy organic products

Within the specialized districts for ecological products existing in hyper and supermarket, the attention of the buyers is attracted especially by the product labels in the case of 38.2% of the respondents (73 people), the aspect of the product packaging in the case of 18.3% of the respondents people) and the promotions that take place in the store in the case of 16.2% of respondents (31 people). Less attention is paid to the arrangement of products on the shelf (15.2%) or billboards (12%).

Sources of information on organic products and the perception of their effectiveness

The main sources of information on organic products are that we could identify are: the internet (50.3%), family/friends (42.9%), promotion made by producers (38.2%). Other sources of information are: producers' stands at specialized fairs (19.90%), information campaigns (14.7%), product tastings (14.1%). Respondents consider that the least efficient source of information is the agricultural profile program broadcast on national television.

On a scale from 1 to 5, the maximum efficiency of the various sources of promotion is perceived in the following order: the organization of tastings in large stores (98 people); organization of fairs specially designed for organic products (86 people); open day at ecological operators (85 people); broadcasting of radio and TV commercials (78 people). Respondents consider that promotion through documentaries is not effective (about 63%). Although they are students at agricultural faculties, only 43.5% (83 people) of those surveyed stated that they personally knew an ecological operator.

A study published in 2019 that focused on the analysis of consumer behavior regarding the purchase of honey shows that the main sources of information about honey are: beekeepers, honey fairs, newspapers and magazines and the Internet [27].

Qualitative attributes associated with ecological products

Respondents associate organic products with their following benefits: they are healthy (93.2%), they are tasty (71.2%), they are products that contain fewer chemicals (61.8%), they improve the quality of life (51.3%), do not contain synthetic additives (48.7%).

67.6% of respondents are satisfied or very satisfied with the relationship between the quality and price of organic products. Although they are aware of the direct relationship between the quality and price of organic products, the young respondents consider that the price of organic products is high (49.7%) or medium (42.9%).

CONCLUSIONS

Organic agriculture is a dynamic system in Romania, registering in the last 10 years an ascending trend, increasing in the decade

2010-2029 by +156.63% and accounting for 468,887.05 ha in 2020.

In order for Romania to have a healthier society, a sustainable agriculture must be developed and it is necessary to make the population aware of the importance of healthy nutrition. Future development strategies must focus on the development of a sustainable and competitive agri-food sector that will improve the quality of life and ensure living conditions in rural areas close to those in urban areas. Information campaigns for the younger generation are needed to promote organic production systems.

In general, for consumers, organic products are associated with the sustainability of agriculture and the local economy. Respondents believe that such products protect the environment (45%), support family farming (40.3%), support the local economy (40.3%).

There is a need for better promotion and use of food registered on various national and European quality schemes. These quality schemes focus on both healthier food production and food safety and security. The purchase and consumption of these foods registered on national quality schemes (traditional products, with a well-established recipe, organic or mountain) bring multiple benefits on social, environmental and economic sustainability.

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ABSORPTION OF FUNDS ALLOCATED BY SUB-MEASURE 6.1, NATIONAL RURAL DEVELOPMENT PROGRAMME 2014-2020, IN ROMANIA

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Abstract

Sub-measure 6.1 "Support for setting-up young farmers", within the NRDP 2014-2020, aimed to support the establishment for the first time of young farmers as sole heads / managers of an agricultural holding. At the same time, it stimulated young people and young families not to leave the rural area, and those from the urban area and the diaspora, who met the criteria, were attracted to establish an agricultural business in the rural area, to contribute to the development of the area's economy. The paper presents the amounts allocated by sub-measures NRDP 2014-2020 on 20.05.2021 and the distribution of the number of projects selected for funding under sub-measure 6.1, at the level of each county in Romania and regions. At national level, the absorption of funds related to sub-measure 6.1 was very good, being selected financing applications amounting to 438,120,000 Euro, out of the allocated amount of 466,754,112 Euro, which represents a degree of absorption of 93.87%. From the presented data it can be noticed that, in Dâmbovița county, most projects were selected for financing (863 projects), while in Neamț County only 8 projects were registered, for the period 2015-2020.

Key words: *European funds, National Rural Development Programme, Romania, sub-measure 6.1, young farmers*

INTRODUCTION

Approximately one third of the farms in the European Union are located in Romania, representing around 3.9 million holdings. The basic challenges of this sector are increasing competitiveness, accompanied by the restructuring process [3].
The structure of the farms is polarizing, the large and medium farms being in proportion of 7% of the total holdings, but they manage approximately 70% of the agricultural surface, having a clear competitive advantage. In contrast, 93% of holdings own less than 5 hectares, which are subsistence or semi-subsistence farms, which manage about 30% of the agricultural area. These farms are poorly equipped and do not have access to markets. They are also not involved in cooperatives or any other form of association, which would help them to better integrate at the market level.
The average size of the farm is considerably smaller than the European average, of 3.4 ha in Romania, compared to 14.4 ha in the Union. For the entire agricultural sector, access to agricultural credit and insurance is difficult. This applies in particular to small farms.
The strategic objectives and measures for rural development result from the European Union's economic development policies and are based on the principles of subsidiarity and flexibility [6]. According to subsidiarity, member states are free to decide which criteria and programs will receive community support. Depending on the flexibility, priorities and needs must be taken into account in order to achieve the objectives.
Taking into account these objectives and challenges, the "National Rural Development Program" (NRDP) has been set up to implement CAP funding and actions regarding rural development.
Under the NRDP 2007-2013, a large part of the funds was allocated for renovations, village development, improvement of basic services to stimulate the economy, rural

population and rural heritage development, modernization of holdings and increasing the added value of agricultural products and forestry [13].

In the NRDP 2014-2020, the focus was on the modernization of agricultural holdings (sub-measure 4.1), investments in small-scale infrastructure (sub-measure 7.2) and support for setting-up young farmers (sub-measure 6.1).

Sub-measure 6.1 "Support for setting-up young farmers" within the NRDP 2014-2020 had the greatest impact in supporting young farmers. This continued Measure 112 “Setting-up for young farmers”, within NRDP 2007-2013, with a larger amount of money and new eligibility criteria. Both measures were aimed at farmers under the age of 40, who wanted to take over or set up an agricultural holding.

This paper follows the distribution of the number of projects selected for funding under sub-measure 6.1, at the level of each county in Romania and at the Regions level.

MATERIALS AND METHODS

The databases used for the study of the absorption of funds allocated to sub-measure 6.1 “Support for setting-up young farmers” at national level were those presented by AFIR, in the section “Reports and lists”/“Selection reports”.

As the information required for the study was not available in an aggregated manner, those published by AFIR were used to compile an aggregate database with all projects selected for funding under sub-measure 6.1: monthly and final selection reports, erratum in the monthly and final reports, the appeal reports from which only the declared projects selected for funding were extracted, the individual reports with eligible projects whose evaluation was challenged in court and declared eligible following the court decisions.

ITI - Danube Delta selection reports were not taken into account because they represent a distinct allocation to the Danube Delta area and are not the subject of this study.

RESULTS AND DISCUSSIONS

The agricultural holding is a unitary system (territorial, technical, productive, legal, economic) whose main purpose is the capitalization of agricultural land or productive animals in terms of economic efficiency and good environmental conditions [8].

The member states of the European Union have an agricultural structure that varies according to geological, climatic and topographical factors, natural resources and regional activities, lifestyle and social habits.

At European level, our country ranks 6th depending on the agricultural area used, so that in recent years, due to its high agricultural potential, Romania has become an important player on the European agricultural market.

At the same time, Romania stands out in the European Union with a large number of very small farms, which have an economic size below 8,000 Standard Output (SO) and represent a percentage of 94.6% of total farms in Romania, namely 3,237,240 very small farms [5]. It should be mentioned that, at such a high percentage of very small farms in Romania, even the European average is high due to Romanian farms.

The percentage of very small farms at European level is 68.3%, respectively 55.81% without including the very small Romanian farms [5].

Regarding jobs in agriculture out of total jobs, also Romania, with a percentage of 22.8% is well above the European average of 4.5% in 2017 and 4.4% in 2018.

However, the percentage of young farmers in relation to the total number of farmers is below the Union average.

These two elements show that Romania has a large number of farmers, but their average age is high compared to the farmers in the Union. Therefore, the stimulation of young farmers in Romania is essential, not only for the competitiveness of the labour force in agriculture at European level but also for the rejuvenation of the labour force to ensure the agricultural future of Romania.

The percentage allocated to Romania at the level of 2019 was 5.2%.

NRDP 2014-2020 was adopted by the European Commission on May 15, 2015 and was subsequently amended several times, the last amendment before the elaboration of this paper, being from April 28, 2020. This involved a plan to use the € 9.44 billion of public money available for the 7-year period during which it took place. The budget was divided as follows:
- 8.1 billion € from the European Union budget, including 112.3 million € transferred from the CAP direct payments budget;
- 1.34 billion € co-financing from the state budget.

NRDP 2014-2020 focused on 3 priority areas:
- promoting competition and restructuring the agricultural sector;
- environmental protection and climate changes;
- stimulating economic development, creating jobs and improving the quality of life in rural areas.

The effective allocation of the funds related to NRDP 2014-2020, on 20.05.2021 according to the MARD report, was made according to Table 1.

Table 1. Allocation of NRDP 2014-2020 on 20.05.2021

Measure - Sub measure	Allocation 2014-2020 -Euro-	%
M01 - "Actions for knowledge transfer and information actions"		
Sub-measure 1.1 "Support for vocational training and skills acquisition actions"	5,910,092	0.06
Sub - measure 1.2 "Support for demonstration activities and information actions"	360,000	0.00
M02 - "Advisory services, farm management services and relief services" (Article 15)		
Sub-measure 2.1 "Support to help benefiting from the use of advisory services"	3,670,000	0.04
M03 - "Quality schemes for agriproducts and foodstuffs" (Article 16)		
Sub - measure 3.1 "Support for new participation in quality schemes"	500,000	0.01
Sub-measure 3.2 "Support for information and promotion activities implemented by groups of producers in the internal market"	5,581,232	0.06
M04 - "Investments in physical assets" (Article 17)		
Sub - measure 4.1 "Investments in agricultural holdings" including ITI Danube Delta	874,878,522	9.27
Sub-measure 4.1a "Investments in fruit-growing holdings" including ITI Danube Delta	301,680,886	3.20
Sub-measure 4.2 "Support for investments in processing/marketing and/or development of agricultural products" including ITI	393,348,167	4.17
Sub - measure 4.2 "GBER State aid scheme"	95,500,000	1.01
Sub-measure 4.2 "De minimis aid scheme"	5,500,000	0.06
Sub-measure 4.2a "Investments in processing / marketing of products from the fruit-growing sector"	35,429,439	0.38
Sub-measure 4.3 "Investments in infrastructure related to development, modernisation or adaptation of agriculture and forestry - irrigations" including ITI Danube Delta	440,978,719	4.67
Sub-measure 4.3 "Investments in infrastructure related to development, modernization or adaptation of agriculture and forestry - agricultural access infrastructure" including ITI Danube Delta	133,298,233	1.41
Sub-measure 4.3 "Investments in infrastructure related to development, modernisation or adaptation of agriculture and forestry - forest infrastructure" including ITI Danube Delta	100,971,119	1.07
M05 - "Restoring agricultural production potential affected by natural disasters and catastrophic events and the establishment of appropriate preventive measures" (Article 18)		
Sub-measure 5.1 "Support for investments in preventive actions to reduce the consequences of natural disasters, adverse climatic events and catastrophies"	24,775,003	0.26

Measure - Sub measure	Allocation 2014-2020	%
Sub-measure 5.2 "Support for investments to restore agricultural land and production potential damaged by natural disasters, adverse environmental conditions and catastrophies"	3,677,431	0.04
M06 - “Farm and business development” (Article 19)		
Sub - measure 6.1 "Support for setting-up young farmers"	466,754,112	4.95
Sub - measure 6.1 "Support for setting-up young farmers" - ITI	10,000,000	0.11
Sub-measure 6.2 "Support to the establishment of non-agricultural activities in rural areas"	106,583,304	1.13
Sub-measure 6.2 "Support to the establishment of non-agricultural activities in rural areas"- ITI	5,000,000	0.05
Sub - measure 6.3 "Support for the development of small farms"	246,471,271	2.61
Sub - measure 6.3 "Support for the development of small farms" - ITI	5,000,000	0.05
Sub-measure 6.4 "investments in creation and development of non-agricultural activities"	156,503,969	1.66
Sub-measure 6.4 "investments in creation and development of non-agricultural activities"- ITI	10,000,000	0.11
Sub - measure 6.5 "Scheme for small farmers"	6,000	0.00
M07 - "Basic services and village renewal in rural areas" (Article 20)		
Sub-measure 7.2 "Investments in the creation and modernization of small-scale infrastructure - water / wastewater infrastructure" including ITI Danube Delta	1,108,947,145	11.75
Sub-measure 7.2 "Investments in the creation and modernization of small-scale infrastructure - road infrastructure of local interest" including ITI Danube Delta		
Sub-measure 7.2 "Investments in the creation and modernization of small-scale infrastructure - educational and social infrastructure" including ITI Danube Delta		
Sub - measure 7.6 "Investments associated with the protection of cultural heritage"	188,010,999	1.99
Sub-measure 7.6 "Investments associated with the protection of cultural heritage" - ITI Danube Delta	9,000,000	0.10
M08 - "Investments in forest area development and improvement of the viability of forests" (Articles 21-26)		
Sub-measure 8.1 "Afforestation and creation of woodland"	46,786,653	0.50
M09 - "Setting up of producer groups and organisations in agriculture and forestry" (Article 27)		
Sub-measure 9.1 "Setting up of producer groups"	16,836,313	0.18
Sub-measure 9.1a "Setting up of producer groups in the fruit-growing sector"	3,200,811	0.03
M10 - *"Agri-environment and climate"*	835,317,262	8.85
M11 -"*Organic farming”*	247,038,159	2.62
M13 - " *Payments to areas facing natural or other specific constraints"*	1,522,717,575	16.13
M14 - *“Animal welfare”*	792,480,077	8.40
M15 - " *Forest-environmental, climate services and forest conservation*" (Article 34)		
Sub-measure 15.1 "Payment for forest-environmental and climate commitments"	90,147,754	0.96
M16 - "Cooperation" (Article 35)		
Sub-measure 16.1 "Support for establishment and operation of operational groups (GOs), for the development of pilot projects, new products"	6,723,721	0.07
Sub-measure 16.1a "Support for the establishment and operation of operational groups, development of pilot projects, products and processes - fruit-growing sector"	5,819,040	0.06
Sub-measure 16.4 "Support for horizontal and vertical cooperation between actors in the supply chain"	12,385,582	0.13
Sub-measure 16.4 "Support for horizontal and vertical cooperation between actors in the supply chain - fruit-growing sector"	6,428,560	0.07
M17 - "Risk management" (Article 36)		
Sub-measure 17.1 "Crop, animal and plant insurance premium"	23,699,076	0.25

Measure - Sub measure	Allocation 2014-2020	%
M19 - "Support for LEADER local development (CLLD - Community-led local development)" (Article 35 of Regulation (EU) No. 1303/2013)		
Sub - measure 19.1 "Preparatory support for the development of local development strategies"	1,990,183	0.02
Sub-measure 19.2 "Support for implementation of operations under the CLLD strategy"	495,641,759	5.25
Sub-measure 19.3 "Preparation and implementation of cooperation activities of the local action group" - Component A "Preparatory technical assistance for the cooperation projects of the LAGs" and Component B "Implementation of the cooperation activities of the selected LAGs"	16,986,768	0.18
Sub-measure 19.4 "Support for running costs and animation"	123,013,164	1.30
Measure 20 " *Technical assistance for Member States" (Articles 51-54)*	176,692,820	1.87
Measure 21 *"Specific measures to provide exceptional temporary support under EAFRD in response to the COVID-19 outbreak"*	182,500,000	1.93
Financial instruments under sub-measures 4.1, 4.1a, 4.2, 4.2a and 6.4	93,973,930	1.00
Total	9,438,714,849	100.00

Source: Own calculation based on data provided by [9, 12].

The highest allocations at the level of measure/sub-measure were for M13 - 16.13%, followed by sub-measure 7.2 - 11.75% and sub-measure 4.1 - 9.27%. However, it should be noted that M13 did not have any projects submitted under the program, although it benefited from the largest allocation.

Regarding the allocation by Measure level, excluding M13, the measures that benefited from the highest allocations were:

1. M04 with a total of 25.23% of the amount allocated to the Program;
2. M07 - 13.84%;
3. M06 - 10.66%.

Thus, the investment measures M04 and M06 together totalled 35.89% of the entire amount allocated, the highest percentage allocation of the Program.

Sub-measure 6.1 was included in Measure 06, “Farm and business development” and was one of the measures that was part of the scope of intervention 2B “Facilitating the entry into the agricultural sector of properly qualified farmers and, in particular, the renewal of generations” and at the same time in the secondary domain ID 3A, according to the Regulation of the European Union no. 1305/2013, art. 5 [11]. The non-refundable support through sub-measure 6.1 “Support for setting-up young farmers” was non-refundable in proportion of 100% and its value was of maximum 50,000 euros.

It was granted in two instalments, namely:

- tranche 1 of 75% at the time of signing the contract with AFIR;
- tranche 2 of 25% at the time of its request, within a maximum of 3 years from the first instalment, when the applicant was fulfilling its commitments from the business plan.

The total public contribution for this sub-measure was supported from two sources:

- 85% of the funds are European contributions through the EAFRD;
- 15% of the funds are national contributions from the state budget [1].

Sub-measure 6.1 had a total allocation of 4.95% of the total Program and a percentage of 46.38% of Measure 06, representing the highest allocation within it.

The purposes of the sub-measure were:

- the installation of a young farmer for the first time in charge of an agricultural holding as head of the holding;
- improving management, increasing the competitiveness in the agricultural sector, complying with the requirements of environmental protection, hygiene and animal welfare and safety measures at work;
- the sub-measure provided an opportunity for young people with a minimum qualification in the agricultural field to set up as managers of a farm;
- increasing the number of young farmers who started to practice agriculture in Romania;
- encouraging young people to move to rural areas.

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The condition of a young person under 40 years of age was fulfilled if the applicant was not yet 41 years old at the time of applying for funding. The objectives proposed by the business plan were divided into two types, mandatory and additional. From the last category at least 3 had to be met. All the objectives had to be met until the request for the second payment tranche was requested, except for the mandatory objective of changing the domicile, registered office or place of work.

The selection criteria established the tie-breaking score of the project, if projects with a total value higher than the amount of money allocated to the submission session were submitted. These were:

-PS1 "Priority sector principle" - max 30 points,

-PS2 "Principle of merging holdings" - max 15 points,

-PS3 „Principle of qualification level in the agricultural field” - max 35 points,

- PS4 "Principle of the agricultural potential of the area" - max 15 points,

-PS5 "Principle of native breeds/indigenous varieties" - max 5 points,

Also, based on the score, the quality threshold of the submission stage within a project submission session was established. This quality threshold defines a minimum score below which projects cannot be submitted at that stage. The score for each quality threshold and each stage is decreasing from one stage to another. This system allows the initial submission of projects with the highest score, and over time, projects with lower scores can also be submitted. The biggest advantages of this system are the postponement of project submissions over a longer period of time and the limitation of the submission of projects with low scores that could have been eligible but unfunded due to the lack of funds available up to that score.

For sub-measure 6.1 "Support for setting-up young farmers", 466 million euros were allocated out of the total public allocation of approximately 9.44 billion Euros (Table 1) [10]. This money was distributed annually during the project submission sessions and was allocated until the update of the report on 20.05.2021, in the amount of 438,120,000 Euro, totalling 10,674 selected funding applications. The projects were evaluated at county level, through OJFIR (County Office for Financing Rural Investments) for each county, these being immediately subordinated to CRFIR (Regional Center for Financing Rural Investments) for the 8 Regions in Romania [7] (Fig. 1).

Fig. 1. Map of Regions and related counties
Source: [2].

According to Table 2, there are differences in performance between the counties with the most projects selected for funding and the counties with the fewest selected projects.

In the best performing county, Dâmbovița (863 projects), more projects were selected for funding than the sum of the last 18 counties (801 projects), from position 24 downwards.

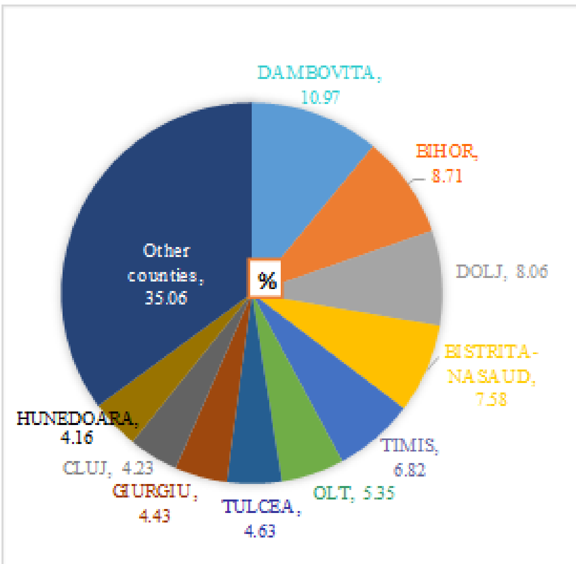

Fig. 2. Percentage distribution of projects for counties with a percentage of over 4% of the total (sub-measure 6.1)
Source: Own calculation based on data provided by [2]

Table 2. Distribution of the number of projects at the level of each county in Romania (sub-measure 6.1)

Position	County	Non-Mountain			Mountain			Mixed		Total
		2015	2016	2017	2015	2016	2017	2018	2020	
1	DAMBOVITA	112	466	154	4	19	15	13	80	863
2	BIHOR	109	201	46	30	74	125	52	48	685
3	DOLJ	184	288	83	0	0	0	39	40	634
4	BISTRITA-NASAUD	18	19	2	88	229	206	3	31	596
5	TIMIS	118	247	77	0	3	2	35	54	536
6	OLT	110	225	68	0	0	0	7	11	421
7	TULCEA	143	156	45	0	0	0	4	16	364
8	GIURGIU	76	181	73	0	0	0	8	10	348
9	CLUJ	43	47	6	37	63	74	25	38	333
10	HUNEDOARA	18	15	6	38	128	116	3	3	327
11	CARAS-SEVERIN	30	30	5	50	74	77	10	13	289
12	GALATI	47	109	35	0	0	0	4	8	203
13	VRANCEA	64	99	10	1	3	5	2	6	190
14	CONSTANTA	59	70	12	0	0	0	2	12	155
15	MEHEDINTI	45	74	10	5	6	8	0	1	149
16	IALOMITA	39	63	15	0	0	0	12	10	139
17	GORJ	24	15	0	34	28	24	0	7	132
18	SATU-MARE	22	68	28	0	0	0	1	10	129
19	ARAD	13	44	11	3	10	10	12	19	122
20	BRAILA	29	67	14	0	0	0	1	7	118
21	COVASNA	9	10	7	17	22	45	7	0	117
22	ALBA	17	4	0	17	21	25	0	25	109
23	ARGES	23	29	5	10	22	12	0	3	104
24	MARAMURES	3	6	3	7	21	49	2	8	99
25	BUZĂU	24	42	8	2	4	5	1	3	89
26	IASI	24	30	6	0	0	0	4	13	77
27	BOTOSANI	10	47	2	0	0	0	7	10	76
28	SALAJ	14	40	9	0	0	1	2	8	74
29	VASLUI	10	29	10	0	0	0	3	7	59
30	SUCEAVA	4	13	2	0	10	6	4	6	45
31	TELEORMAN	11	17	5	0	0	0	3	9	45
32	VALCEA	6	14	2	9	8	3	0	3	45
33	BRASOV	1	4	0	11	12	13	0	2	43
34	BACAU	7	11	1	4	5	7	0	2	37
35	CALARASI	10	16	6	0	0	0	1	1	34
36	MURES	0	3	1	0	0	3	0	13	20
37	ILFOV	7	7	1	0	0	0	1	1	17
38	SIBIU	1	3	1	1	3	1	1	4	15
39	PRAHOVA	2	7	0	0	0	1	0	0	10
40	HARGHITA	0	0	0	0	2	3	0	3	8
41	NEAMT	1	3	0	0	1	2	0	1	8

Source: Own calculation based on data provided by [2].

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As can be seen from Figure 2, the top 10 counties in the ranking hold 64.94% of all projects selected for funding at national level.
The top 10 counties are: Dâmbovița-10.97%, Bihor-8.71%, Dolj-8.06%, Bistrița-Năsăud-7.58%, Timiș-6.82%, Olt-5.35%, Tulcea-4.63%, Giurgiu-4.43%, Cluj-4.23% and Hunedoara-4.16%.

The other counties together make up a percentage of 35.06%.
The number of projects selected for funding in the 2018 and 2020 sessions (Mixed projects) is substantially lower than the number of projects selected in previous years, 2015 - 2017 (Mountain and Non-mountain projects), as shown in Figure 3, according to Table 2.

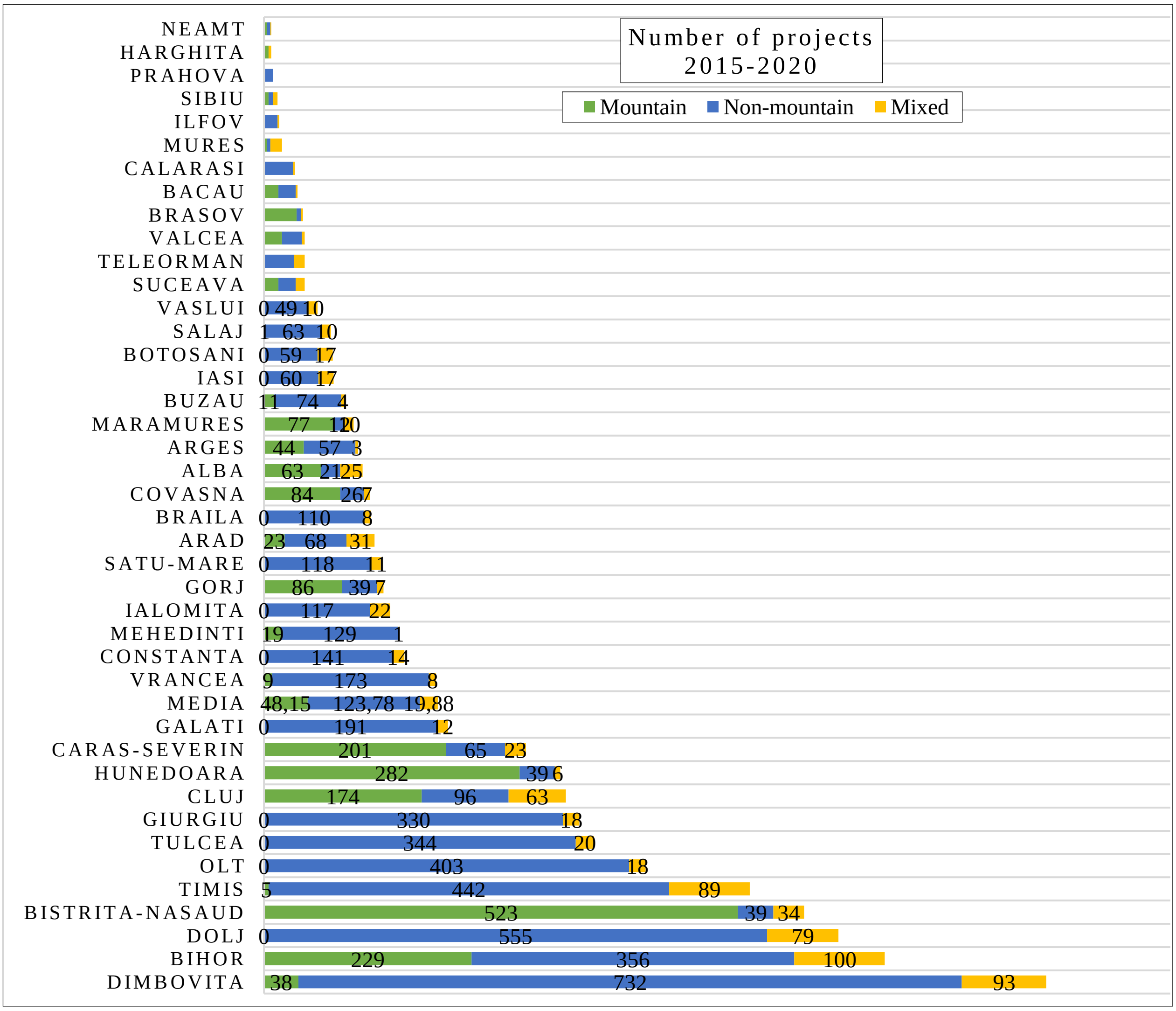

Fig. 3. Number of projects selected for each county (sub-measure 6.1)
Source: Own calculation based on data provided by [2].

This is mainly due to the small amount of money allocated out of the total of 466,754,111 Euro, namely:
- 11,000,000 Euro allocation in 2018;
- 23,022,207 Euro allocation in 2020.
Also, the difference between the best performing counties and the other counties is highlighted again, here, with an average of 191.81 projects being situated between position 12 and position 13. Thus, all counties under position 12 are below the national average in terms of the number of projects on sub-measure 6.1 selected for funding.
Figure 4 shows the distribution by Region of the projects selected for funding. Here can be seen the grouping of Regions into high-performing regions and low-performing regions.

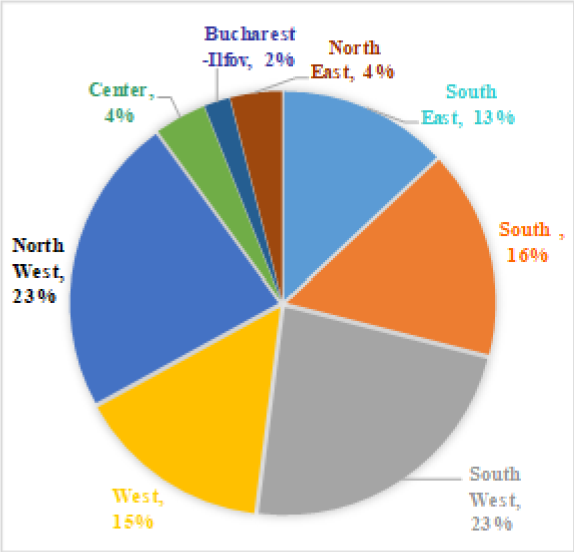

Fig. 4. Distribution of projects selected for funding at national level by Regions (sub-measure 6.1)
Source: Own calculation based on data provided by [2].

The best performing regions, North West with 23% of projects and South West also with 23% of projects, bring together the best performing counties.
Thus, Region 6, North West, brings together the following counties, with the corresponding position in the national top: Bihor - 2, Bistrița – Năsăud - 4, Cluj - 9, Satu-Mare - 18, Maramureș - 24, Sălaj - 28.
Region 4, South West, brings together the following counties with their position in the national ranking:
Dolj - 3, Olt - 4, Mehedinti - 15, Gorj - 17, Vâlcea - 32.
The county with the most projects, Dâmbovița, is part of the South Region and together with Giurgiu County hold the absolute majority of the projects selected for funding in this Region.
Among the Regions with the fewest projects, the Bucharest-Ilfov Region is led by Ialomița with 139 selected projects. The city of Bucharest has no project because it is entirely an urban area, without access to rural areas, being surrounded on all sides by Ilfov County.
The two Regions 7, Center, and 1, North East, are highlighted by the smallest number of selected projects.
In addition, the project submission session for the Diaspora was also opened on the budget of this program, which will lead to the allocation of even more funds and consequently the increase of the current absorption percentage.
Thus, under sub-measure 6.1, despite absorption discrepancies between counties or regions, the allocation of funds at national level was a success.
At national level, it is critical that in the period 2014-2020 in the agricultural field (as well as in other areas) the measures taken will help eliminate discrepancies with other countries, especially in the context of the changes that will follow [4].

CONCLUSIONS

The funds allocated to sub-measure 6.1 of the EAFRD contribution and the State Budget had a positive impact on encouraging young farmers to set up on an agricultural holding.
More than anything, there were 10,523 young people involved in agriculture, 438,120,000 Euros attracted to the national economy, thousands of jobs created and thousands of young people stimulated to qualify in agriculture.
They also meant commitments from the beneficiaries to market their own production of at least 65,178,000 Euro (20% of the first tranche of support, which represents 75% of the total amount attracted).
Although at county level, the discrepancies between the counties at the top of the ranking and those that were in the last places, was as high as possible, at national level the degree of absorption of 93.87% was good.
The field study is recommended, in order to see what are the obstacles that the counties at the bottom of the ranking face, as well as what are the good practices that the leading counties have managed to perform.

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ECONOMIC EFFECT OF FERTILIZING WITH LUMBREX AND LUMBRICAL BIOPRODUCTS ON BIRD'S FOOT TREFOIL GRASSLAND

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Abstract

During the period 2014 - 2016 in the Research Institute of Mountain Stockbreeding and Agriculture in Troyan was conducted a research experiment to determine the economic effect of imported bioproducts in the following fertilizing variants: 1.Control /untreated/; 2. Lumbrex – 1.5 L/ha; 3. Lumbrex – 2.0 L/ha; 4. Lumbrical - 150 ml/m^2; 5.Lumbrical - 200 ml/m^2. Based on the presented economic indicators, biofertilizer and fertilizing dose were chosen, combining high economic and ecological effect. It was found that for the conditions of light gray pseudo-podzolic soils, fertilizing with Lumbrex at a dose of 1.5 L/ha showed high productivity (11.3 t/ha), the lowest production costs (924.40 BGN/ha), the highest gross profit (2825.60 BGN/ha) and profitability (305.67%). The introduction of this bioproduct in the production of meadow grasses is an alternative for the realization of high yield and economically important technological solution for obtaining ecologically clean fodder production.

Key words*: *bird's foot trefoil (Lotus corniculatus L.), biofertilizers, economic effect

INTRODUCTION

In recent years, there has been an increased interest in organically produced plant and animal products in the world, and in the European Union in particular. In the future, there are all prerequisites for mountain areas to become a major source of organic production. Recently, a research has been carried out to optimize the nutritional regime of forage crops [16, 8]. Emphasis is placed on improving fertilizing models based on more efficient use of nutrients and allowing a reduction in the amount imported into the soil [10]. Alternatives, environmentally friendly solutions for improving the regime are sought, which lead to biological control of soil fertility and realize the economic effect of the applied fertilizing [11, 12, 13, 3]. Fodder production can be economically profitable provided that all agrotechnical events are applied in accordance with the requirements of the crop, in optimal terms, doses and norms, and the yield is high enough to ensure profitability of production [9].
The risk of contamination of the products with hazardous substances is associated with the use of significant amounts of fertilizers. The demand for a high economic effect of the applied fertilizers contradicts the requirement for environmental friendliness of agricultural activity [1]. One of the ways to combine economic efficiency with environmental friendliness is the introduction of alternative fertilizing systems of organic origin [4].
With the launch of the Rural Development Program (RDP) for the period 2014–2020 [14], the expectations for the development of biological farming were increasing, as the EU funding for the cultivation of bioproducts increased 5 times. Such bioproducts are Lumbrical and Lumbrex, which stimulate the development of soil microflora, facilitate the absorption of nutrients in the soil and organogenic elements [2] and improve the quality parameters of plants [17]. Ecologically clean products, with high taste and nutritional qualities, are obtained from grasslands that have been fertilized with biohumus. Applied to bird's foot trefoil, they increase dry matter yield [5], bird's foot trefoil share in the grassland [6] and improve feed quality [7].
In the previous studies on grass fodder crops there is no data concerning the economic and ecological efficiency as a result of applied biofertilizers. The calculation of parameters such as net income, production cost price and production costs would determine the

economic effect of the applied fertilizing applied on bird's foot trefoil.

Establishing the parameters, such as production costs, production cost price and gross revenues (gross income) would determine the economic effect of the applied fertilizing on bird's foot trefoil.

The objective of the present study is to determine the economic effect of fertilizing with biofertilizers on bird's-foot-trefoil grassland, with a view to their effective application in practice.

MATERIALS AND METHODS

The study was conducted at the Research Institute of Mountain Stockbreeding and Agriculture in Troyan, in the period 2014-2016 on light gray pseudo-podzolic soil. It is based on data from Bozhanska (2020) [6] for the dry matter yield of bird's foot trefoil by years and average for the research period.

The experiment was performed by the block method in four replications, with 5 m^2 plot size. Biofertilizers, such as Lumbrex and Lumbrical were included for testing in a field experiment of a pure crop grassland covered by bird's foot trefoil cultivar "Leo" in the following variants: The experimental variants were: 1. Control /untreated/; 2. Lumbrex – 1.5 L/ha; 3. Lumbrex – 2.0 L/ha; 4. Lumbrical - 150 ml/m^2; 5. Lumbrical - 200 ml/m^2. Bioproducts were produced in Plovdiv region.

The traditional for the region technology for growing artificial grasslands has been applied [8].

The economic assessment was established on the basis of detailed technological maps developed for each fertilizing variant. The valuation of the seeds, fertilizers, materials, live and material labor used in the technology for calculation of the total production costs was performed at the market prices for 2016. The production was organized using own land and own mechanized equipment. The value of production was calculated on the basis of average prices for the analyzed period.

The main indicators determining the economic evaluation of the results of the experiment are gross revenues (BGN/ha) and profitability (%) [4]. They give an idea of the economic efficiency of the applied types of bioproducts and their doses. The economic assessment is developed on the basis of dry matter yield (t/ha) [6].

Research indicators were: production costs (BGN/ha), production cost price (BGN/t) and gross profit (BGN/ha) [1].

Statistical processing of dry matter yield data was performed by variance analysis (ANOVA) to establish the reliability of LSD differences.

RESULTS AND DISCUSSIONS

Dry matter yield

Table 1 presents data on the yield of dry matter from fertilizing with organic fertilizers, such as Lumbrex and Lumbrical on pure crop with bird's foot trefoil for each year and on average for the period.

Table 1. Dry matter yield of bird's foot trefoil fertilized with Lumbrical and Lumbrex over the years and average for the period 2014-2016, (t/ha)

Variants	2014		2015		2016		Average for the period	
	t/ha	% to C	t/ha	% to C	t/ha	% to C	t/ha	% to C
Control	5.6	100.0	11.6	100.0	13.0	100.0	10.1	100.0
Lumbrex 1.5 L/ha	5.6	100.6	13.4	114.8	14.8	114.0	11.3	111.8
Lumbrex 2.0 L/ha	5.6	101.3	13.0	111.1	14.0	108.3	10.9	108.1
Lumbrical 150 ml/m^2	5.7	102.2	13.3	114.0	14.9	114.9	11.3	112.2
Lumbrical 200 ml/m^2	5.7	101.9	13.5	116.3	13.4	103.0	10.9	107.9
LSD 0.05	0.6	11.0	1.3	11.1	2.9	16.9	0.9	8.5
LSD 0.01	0.9	15.4	1.8	15.6	3.1	23.7	1.2	11.9
LSD 0.001	1.2	21.8	2.6	22.0	4.3	33.5	1.7	16.9

*LSD- Limited Significant Differences.
Source: Based on data publication from Bozhanska (2020) [6].

The dry matter yield ranged from 5.6 t/ha for the control to 5.7 t/ha when fertilized with Lumbrical at a dose of 150 ml/m^2 and 200 ml/m^2. Low productivity was due to the biological characteristics of bird's foot trefoil, associated with its slow growth rate during the initial stages of development. No difference in yield was found, both in terms of the type of bioproduct used and its dose. This, in turn, had an impact on the presented economic indicators in the first experimental year for perennial forage crops, such as bird's foot trefoil.

In the second experimental year (Table 1), the total yield obtained as a result of the applied bioproducts significantly exceeded that of the previous year. These results are explained by the stimulating impact of the microbiological processes in the soil, which is confirmed by the use of similar bioproducts by Atanasov et al. (2016) in greenhouse tomatoes. The data show the proven positive effect of Lumbrical 200 ml/m^2 (13.5 t/ha), Lumbrex 1.5 L/ha (13.4 t/ha) and Lumbrical 150 ml/m^2 (13.3 t/ha) compared to the control variant with 11.6 t/ha. Regarding the doses administered, the difference in the administration of Lumbrex is more significant than that of Lumbrical. The lower dose for Lumbrex (var. 2) showed a higher effect on dry matter yield than the higher dose, while for Lumbrical the trend was the opposite. The higher dose (var. 5) had a higher effect than the lower one (var. 4).

As bird's foot trefoil reached maximum productivity in the second and third year of its development, the high yield of dry matter (Table 1) in the third year is fully explained by the biology of the crop. The high stems and the large number of branches explain the obtained high yield, which for the treated variants ranged from 13.4 (var. 5) to 14.9 (var. 4) t/ha. The action of biofertilizers combined with the favourable climate conditions in 2016 determined the high productivity in all fertilizing variants.

On average for the study period, the productivity from the Lumbrical treatment alone at a dose of 150 ml/m^2 (Table 1) was the most effective, as a result of which the productivity exceeded the control by 12.2%. The yield value is extremely close when fertilizing with Lumbrex at a dose of 1.5 L/ha, respectively 11.8% above the yield of the control. The productivity of the other variants is lower, which is important for differentiated use of biological products and their careful application as a stage of bird's foot trefoil technology.

The yield had an impact on the presented economic indicators.

Economic effect of fertilizing of bird's foot trefoil with Lumbrex and Lumbrical

The analysis of the production costs (Table 2) on the level of efficiency shows that their volume increased from 1,668.2 to 1,824.1 BGN/ha for the applied bioproducts compared to that of the control variant. The higher costs in the first year compared to the other two years are impressive. The differences in the costs in the different variants are not significant, but their higher values are explained by the operations performed to create the crop, including different mechanical tillage. The events for maintaining the crop and its mowing are also included during the specified period. Higher costs were incurred for fertilizing with Lumbrical (1,771.7 and 1,824.1 BGN/ha) compared to Lumbrex (1,668.2 and 1,686.9 BGN/ha), which is due to the difference in the price of bioproducts. The low production costs in the control variant are determined by the lack of fertilizing costs. The highest production costs for treatment with Lumbrical at a dose of 200 ml/m^2 exceed those of the control by 289.9 BGN/ha. The highest cost price of dry matter was reported for the grassland fertilized with Lumbrical at a dose of 200 ml/m^2 or 3.200 BGN/t. Since the production cost price is mainly determined by production costs and yield, and they are the highest in the above-mentioned variant, this explains the resulting cost price in the different variants. The cost price values follow the course of the received production costs. The cost price data for the administration of Lumbrex in the two doses is similar (2.978 and 3.012 BGN/t). In the case of variant 4, the obtained cost price was lower, respectively 3.108 BGN/t at a cost price of 3.200 BGN/t in variant 5. The insignificant differences in the yield and in the production costs by variants explain the results for the cost price of the fodder.

Gross income is affected by the productivity of the grassland. The grasslands that were fertilized with Lumbrical using both doses realized gross income, respectively 1,900 BGN/ha (var. 4) and 1,890 BGN/ha (var. 5). The highest dry matter yield determines the highest values of gross revenues.

The highest gross profit, which directly depends on the revenues and expenses, was registered in the untreated control, respectively 325.8 BGN/ha, as the invested expenses were also the least (1,534.2 BGN/ha). Of the treated crops, the highest gross profit (201.8 BGN/ha) was realized by fertilizing with Lumbrex at a dose of 1.5 L/ha. Almost similar values were reported for the higher fertilizer rate of the same bioproduct (193.1 BGN/ha). The gross profit from fertilizing with Lumbrical at the lower dose was twice as high (128.3 BGN/ha) than the treatment with the higher dose (65.9 BGN/ha). The effect of the fertilizing dose was significantly higher in the indicator of gross profit compared to other indicators.

Profitability is an economic indicator that is determined by the level of gross profit and production costs. Foliar treatment with Lumbrex at a dose of 1.5 L/ha provided the highest profitability, respectively 12.10%. These values are approached by the profitability of fertilizing with the other dose of Lumbrex, respectively 2.0 L/ha, which was 11.45%. For Lumbrical, the profitability values were significantly lower (7.24 and 3.61%).

In the second year, excluding the control variant, the highest economic effect was achieved by fertilizing with Lumbrex at a dose of 1.5 L/ha (Table 2).

This is due to the lowest production costs (572.0 BGN/ha), the lowest cost price (0.427 BGN/t) and the highest gross profit (3888.0 BGN/ha). The rate of profitability is a generalizing economic indicator and gives an idea of the economic evaluation of fertilizing.

The highest profitability was achieved when fertilizing with Lumbrex at a dose of 1.5 L/ha, whose numerical value was 679.72%. High profitability was also obtained with the second administered dose of 2.0 L/ha, which was respectively 630.88%. The profitability data show that when comparing both bioproducts from an economic point of view, the effect of the application of Lumbrex was much higher than Lumbrical.

The analysis of the impact of the production costs of the two types of fertilizers in both doses during the third experimental year on the efficiency shows that their volume increased from 533.0 to 685.2 BGN/ha compared to that of the control variant. The lowest costs were for the production of dry matter (533.0 BGN/ha) when fertilizing with Lumbrex at a dose of 1.5 L/ha. The highest production costs (685.2 BGN/ha) were registered in the variant with Lumbrical fertilizing at a dose of 200 ml/m^2. There is a tendency to increase the cost price of fodder obtained with increasing production costs.

Of all the fertilized variants, the grassland treated with Lumbrical at a dose of 200 ml/m^2 (var. 5) had the lowest yield (13.4 t/ha), the highest production costs (685.2 BGN/ha) and the highest production cost price (0.511 BGN/t). The values of gross revenues for fodder obtained after fertilizing with Lumbrical and Lumbrex at a dose of 150 ml/m^2 and 1.5 L/ha (4,960 BGN/ha and 4,920 BGN/ha) are similar. The untreated control showed the highest profitability (973.83%), and the maximum value was reported for the grassland fertilized with Lumbrex at a dose of 1.5 L/ha (823.08%). The high profitability is due to the highest gross profit (4,387.0 BGN/ha) and the high dry matter yield (14.8 t/ha).

On average for the period of the study, the variability of the values of the economic indicators follows the tendency of their variability by years. The analysis shows the maximum production costs of the fodder obtained when treated with Lumbrical at a dose of 200 ml/m^2 (1,079.23 BGN/ha) and minimum when fertilized with Lumbrex at a dose of 1.5 L/ha (924.40 BGN/ha).

Table 2. Economic effect of fertilizing of bird's foot trefoil with Lumbrex and Lumbrical over the years and average for the period

Fertilizing variants	Production costs	Cost price	Gross income	Gross profit	Profitability
	BGN/ha	BGN/t	BGN/ha	BGN/ha	%
2014					
Control	1,534.2	2.739	1,860.0	325.8	21.24
Lumbrex 1.5 L/ha	1,668.2	2.978	1,870.0	201.8	12.10
Lumbrex 2.0 L/ha	1,686.9	3.012	1880.0	193.1	11.45
Lumbrical 150 ml/m^2	1,771.7	3.108	1,900.0	128.3	7.24
Lumbrical 200 ml/m^2	1,824.1	3.200	1,890.0	65.9	3.61
2015					
Control	433.5	0.373	3,880.0	3,446.5	795.04
Lumbrex 1.5 L/ha	572.0	0.427	4,460.0	3,888.0	679.72
Lumbrex 2.0 L/ha	589.7	0.454	4,310.0	3,720.3	630.88
Lumbrical 150 ml/m^2	674.9	0.507	4,430.0	3,755.1	556.39
Lumbrical 200 ml/m^2	728.4	0.539	4,510.0	3,781.6	519.17
2016					
Control	402.3	0.309	4,320.0	3,917.7	973.83
Lumbrex 1.5 L/ha	533.0	0.360	4,920.0	4,387.0	823.08
Lumbrex 2.0 L/ha	549.9	0.393	4,680.0	4,130.1	751.06
Lumbrical 150 ml/m^2	636.5	0.427	4,960.0	4,323.5	679.26
Lumbrical 200 ml/m^2	685.2	0.511	4,450.0	3,764.8	549.45
Average for the period 2014-2016					
Control	790.00	0.782	3,350.0	2,560.0	324.05
Lumbrex 1.5 L/ha	924.40	0.818	3,750.0	2,825.6	305.67
Lumbrex 2.0 L/ha	942.17	0.864	3,620.0	2,677.8	284.22
Lumbrical 150 ml/m^2	1,027.7	0.909	3,760.0	2,732.3	265.87
Lumbrical 200 ml/m^2	1,079.23	0.990	3,620.0	2,540.7	235.42

Source: Own calculation.

Regarding the dose of imported bioproducts, a more significant difference in production costs was observed at Lumbrical, respectively 51.53 points. The production cost price is determined by the level of average yields and the amount of production costs. With an increase in production costs, an increase in the cost of the obtained dry matter yield is established. The grassland fertilized with Lumbrex at a dose of 1.5 L/ha showed the lowest production costs (924.40 BGN/ha) and the lowest production cost price (0.818 BGN/t). The highest values of these indicators were registered in the fertilizing with Lumbrical at a dose of 200 ml/m^2, respectively 1,079.23 and 0.990 BGN/t. Gross revenues (3620 BGN/ha) in fertilizing with Lumbrex and Lumbrical at a dose of 2.0 L/ha and 200 ml/m^2 (var. 3 and 5) were the same due to the similar values of dry matter yield (10.9 and 10.9 t/ha). Obtaining a higher gross profit is based on the use of opportunities to reduce the production cost price in different fertilizing variants. Fertilizing with Lumbrex at a dose of 1.5 L/ha realized the highest gross profit (2,825.60 BGN/ha) and the lowest cost price of the obtained fodder (0.818 BGN/t). The highest gross profit from fodder was obtained after fertilizing with Lumbrex at a dose of 1.5 L/ha (2,825.60 BGN/ha), while the lowest was gathered by fertilizing with Lumbrical at a dose of 200 ml/m^2 (2,540.77

BGN/ha) the lowest. The values of the gross profit also determine the profitability of the imported bioproducts. Maximum profitability was shown by fertilizing with Lumbrex at a dose of 1.5 L/ha (305.67%) and the minimum in fertilizing with Lumbrical at a dose of 200 ml/m^2 (235.42%). The lowest profitability rate compared to control in grassland treated with Lumbrical 200 ml/m^2 makes it economically inefficient. The high productivity (11.3 t/ha), the lowest production costs (924.40 BGN/ha), the highest gross profit (2,825.60 BGN/ha) and profitability (305.67%) when fertilizing with Lumbrex at a dose of 1.5 L/ha determine its high economic effect. This gives grounds for the use of this bioproduct as the most economically feasible technological solution in the production of pure crop grassland with bird's foot trefoil. The present results show that the transition from conventional to biological farming has a practical orientation due to the ability to plan and manage revenues and expenditures. The data from the experiment correspond to those obtained by Stoykova et al. [15] related to the selection of appropriate technological solutions, one of which is the application of organic foliar treatment to grasses and legumes mixtures.

Fertilizing bird's foot trefoil with bioproducts has not only economic but also environmental effect. Recently, more and more farms are introducing an environmentally friendly way of feeding animals. Finding the right management solution is related to combining economic and environmental effects in one.

CONCLUSIONS

Bioproducts, such as Lumbrex and Lumbrical, increased the dry matter yields, which affects the economic effect of the obtained fodder.

The most cost-effective was fertilizing with Lumbrex at a dose of 1.5 L/ha, due to high productivity, the lowest production costs, the highest gross profit and profitability. The introduction of this bioproduct in the production of meadow grasses is an alternative for the realization of high yield and economically important technological solution for obtaining ecologically clean fodder production.

The cultivation of bird's foot trefoil as a pure crop in mountaine areas using Lumbrex and Lumbrical for foliar and soil nutrition is an important element of the technology for the production of meadow grasses of grass and legume species, which can be recommended for practical application.

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USE OF DRONE FOR MONITORING AND PRODUCTION ESTIMATING IN AGRICULTURAL CROPS; CASE STUDY IN WHEAT

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Abstract

The study aimed to estimate wheat production based on aerial images taken with drone. The wheat crop, Alex cultivar, was fertilized with variable doses of nitrogen, in the range 0 - 250 kg ha^{-1} N active substance (a.s.). During the vegetation, drone images were taken on the experimental variants, between April and July 2018. The digital images, jpeg format, were analyzed and the values of the RGB parameters were obtained (R-red, B-blue, G-green; RGB colour system). At the time of biological maturity, wheat production was harvested, which recorded values between 1,896.64 kg ha^{-1} (V1-control), and 4,787.50 ka ha^{-1} (V9). Regression analysis was used to estimate production based on RGB parameters obtained from digital images, taken at four different times. Production prediction (Y_P) was possible in statistical safety conditions (R^2 = 0.997, p <0.001, images from April 29; R^2 = 0.993, p <0.001, images from May 13; R^2 = 0.990, p <0.001, images from 28 May; R^2 = 0.968, p <0.001, images from 1 July). 3D and isoquants models were obtained, which expressed the variation of production according to the R and G parameters. RMSEP, as a prediction safety parameter and the F-test showed different levels of accuracy in predicting wheat production based on parameters R and G (RMSEP = 183.5859 for April 29; RMSEP = 330.3418 for May 13; RMSEP = 386.3834 for May 28; RMSEP = 703.9887 for July 1). The use of drones to obtain information about agricultural land is very useful at farm level, and the study can be adapted to different crops.

Key words: *fertilizers, model, UAV, wheat, yield prediction*

INTRODUCTION

Wheat is one of the first species of plants "domesticated" and cultivated by humans in order to provide food resources [9], [21].
Wheat is grown worldwide on large areas, in different climatic and soil conditions and is one of the main crops for ensuring food security [56], [3], [17], [20].
The high ecological plasticity has made possible the cultivation of wheat in different eco-climatic conditions, and the production of biological material with different adaptations to stress factors, soil types and conditions, agricultural systems, cultivation technologies, productivity and quality indices [52], [44], [45], [51], [15].
Market studies on wheat production, along with other cereals, were also carried out, due to the importance and share of wheat in the trade balance of agricultural products [14], [46], [47], [1], [34].
Wheat is suitable to be cultivated in different agricultural production systems. The elements of technology have evolved a lot, in relation to new genotypes, more productive, more adapted to soil and climate conditions, to stress factors, with better baking and industrialization indices [5], [25], [2], [10], [19].
Cultivation technologies require a series of inputs, and the elements of technology are permanently adapted in relation to the soil as a nutrient medium [7], [26], [39], range of agricultural machinery [37], [28], [40], water regime, water consumption and crop irrigation [33], [4], fertilization (fertilizer assortments, methods and application techniques) [6], [11], plant protection [36], [12], [27].
Wheat goes through a long period of vegetation, from sowing to harvesting, and crop monitoring is necessary to manage the vegetation in order to obtain profitable yields [66], [13].
Wheat crop management integrates informational, decision-making and operational elements, in order to achieve the proposed objectives at the level of agricultural crops

and the farm.

Agricultural crops have variable areas, in relation to the agricultural system and the type of farm. Agricultural crop management requires knowledge of the status of each crop, and this involves monitoring crops for which different techniques and methods have been developed and implemented [18], [54], [41], [60], [42]. Crop monitoring based on satellite or aerial imagery has a number of advantages [29], [58], [62], [8], [38]. The present study used aerial images, taken with a drone, in order to estimate wheat production.

MATERIALS AND METHODS

The experiment was organized within the Didactic and Experimental Resort, BUASVM, Timisoara, in the agricultural year 2017 - 2018. The Alex wheat cultivar was grown in a medium fertility chernozem soil conditions.

Fertilization was performed with different doses of ammonium nitrate, in the range 0 - 250 kg a.s. N ha^{-1} (a.s. - active substance). Based on fertilization, 11 experimental variants were performed (Figure 1).

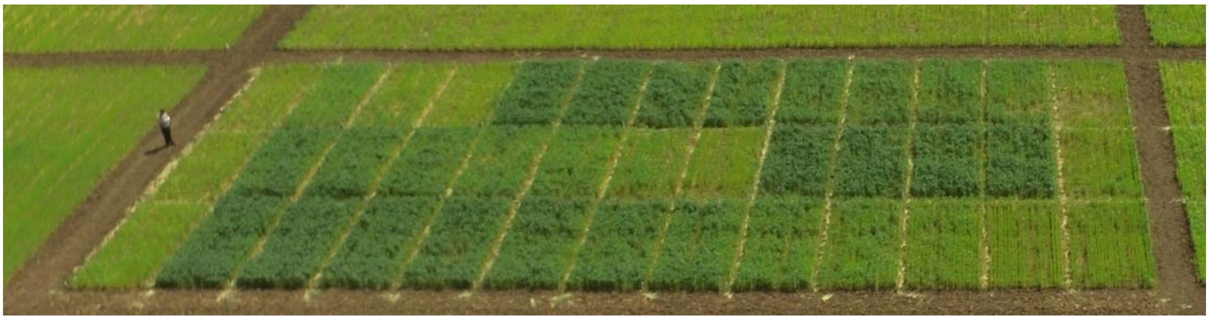

Fig. 1. Aspect from the experimental field, spring 2018
Source: original image, author's image.

A DJI Phantom series drone was used to capture aerial images.

The images were captured between April and July 2018 at different moments of vegetation of the wheat crop, Alex cultivar.

The digital images were analyzed to obtain the spectral information in the RGB system [48].

The experimental results were analyzed in terms of statistical safety (ANOVA test). Regression analysis was used to find models for estimating production, such as some equations, in relation to RGB values from digital images. Statistical safety parameters of the obtained equations were taken into account to certify the degree of safety of the obtained models (p, R^2, F-test). RMSEP, equation (1), was also used to comparatively evaluate the safety of the production prediction based on the RGB values obtained in relation to the images date.

$$RMSEP = \sqrt{\frac{1}{n}\sum_{j=1}^{n}\left(y_j - \hat{y}_j\right)^2} \quad (1)$$

PAST software [22] was used for statistical data analysis. Wolfram Alpha (2020)[64] was used to generate the graphs.

RESULTS AND DISCUSSIONS

Nitrogen-controlled fertilization, with variable doses in the range 0 - 250 kg ha^{-1} N a.s. (active substance) determined the differentiated growth and development of the plants on the experimental variants. This led to the variation of production between 1,896.64 kg ha^{-1} (V1) and 4,787.50 kg ha^{-1} (V9) (Table 1).

In response to variable fertilization, wheat plants had a differentiated growth and development, and this aspect was reflected in the images taken with the drone at different times of vegetation.

The taken digital images were analyzed, and the values of the RGB colour parameters were obtained, with graphical representation in Figures 2 - 5.

Table 1. Experimental variants and values of wheat production, Alex cultivar

Experimental Variants	N (kg ha^{-1})	Y (kg ha^{-1})
V1 (Ct)	0	1,896.64
V2	25	2,262.42
V3	50	3,131.25
V4	75	3,937.50
V5	100	4,018.75
V6	125	4,375.00
V7	150	4,512.64
V8	175	4,750.00
V9	200	4,787.50
V10	225	4,562.50
V11	250	4,181.25

Source: Original data from the experimental field.

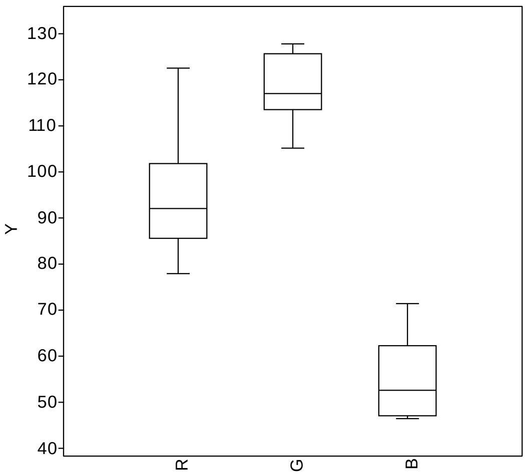

Fig. 2. Distribution of RGB values resulting from the analysis of images captured on April 29, 2018
Source: Original data, obtained from the analysis of digital images.

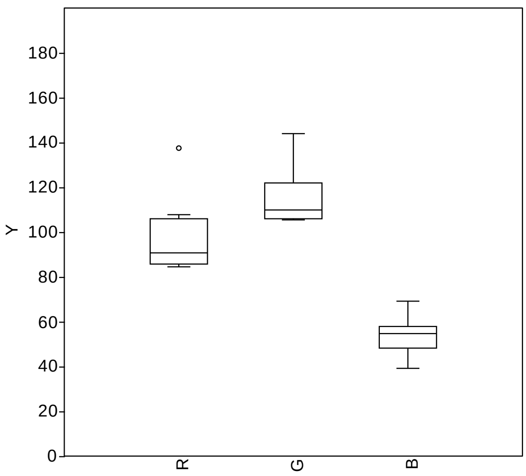

Fig. 3. Distribution of RGB values resulting from the analysis of images captured on May 13, 2018
Source: Original data, obtained from the analysis of digital images.

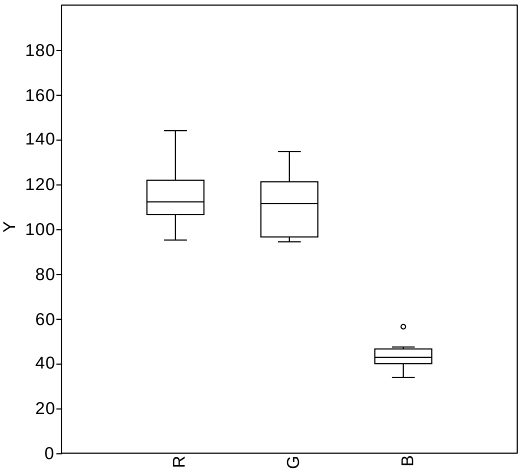

Fig. 4. Distribution of RGB values resulting from the analysis of images captured on May 28, 2018
Source: Original data, obtained from the analysis of digital images.

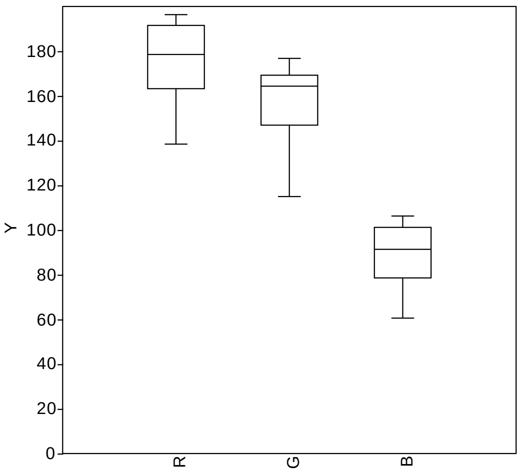

Fig. 5. Distribution of RGB values resulting from the analysis of images captured on July 01, 2018
Source: Original data, obtained from the analysis of digital images.

Through regression analysis, the possibility of estimating wheat production based on colour parameters (RGB) obtained from aerial image analysis was tested.

The estimation of wheat production (Y_P) based on the values of RGB parameters obtained from the images taken at different dates, was possible in relation to R and G, in statistical safety conditions; $R^2 = 0.997$, $p < 0.001$, date April 29; $R^2 = 0.993$, $p < 0.001$, date 13 May; $R^2 = 0.990$, $p < 0.001$, date 28 May; $R^2 = 0.968$, $p < 0.001$, date 01 July, according to the general relation of the type of equation (2).

$$Y_P = ax^2 + by^2 + cx + dy + exy + f \quad (2)$$

where:
Y_P - wheat production predicted;
x – R – red colour parameter;
y – G – green colour parameter;
a, b, c, d, e, f - coefficients of the equation (2).

The values are shown in Table 2.
The graphical distributions of the Y_P values in relation to R and G, at different images dates, are presented in Figures 6 - 9.

Table 2. The values of the coefficients of the equation (2) in relation to the date of taking the images

Coefficients of the equation	Date taken of the images			
	April 29	May 13	May 28	July 01
a	2.1158926	-24.2122337	-56.6921688	-4.7607285
b	6.2395442	-32.6728229	-54.2965244	-2.1216543
c	851.3914815	-2047.8901262	690.7087314	655.6380987
d	-518.2509759	1857.9479580	-606.6228166	-732.1025761
e	-10.8542525	58.1380359	110.6000609	7.3470566
f	0	0	0	0

Source: Original values resulting from the analysis of experimental data.

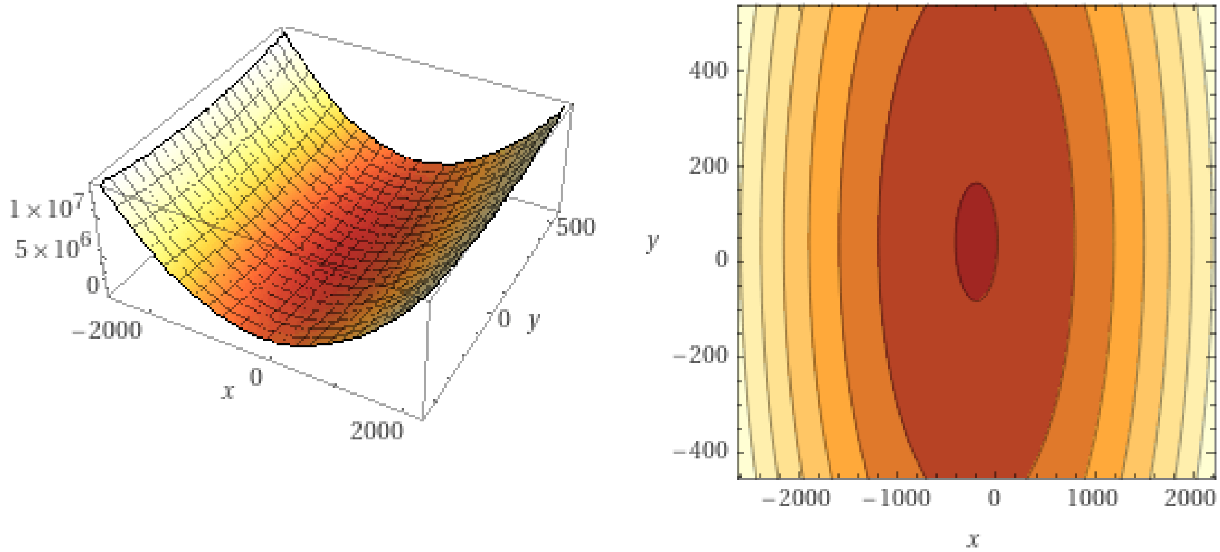

Fig. 6. Graphic distribution, as 3D model and isoquants, of Y_P in relation to R (x-axis) and G (y-axis) parameters, Alex wheat cultivar (images captured on April 29)
Source: original graphs generated based on experimental data.

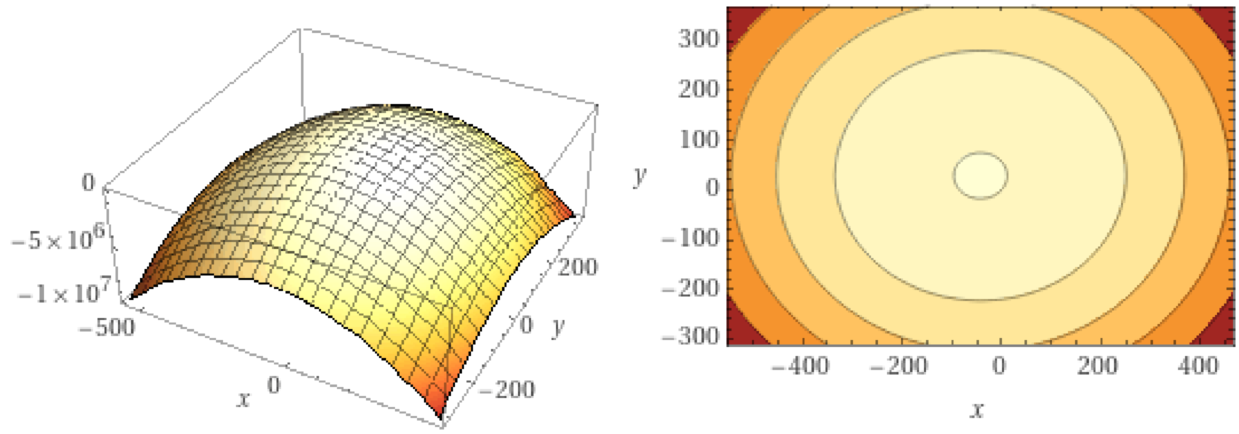

Fig. 7. Graphic distribution, as 3D model and isoquants, of Y_P in relation to R (x-axis) and G (y-axis), Alex wheat cultivar (images captured on May 13)
Source: original graphs generated based on experimental data.

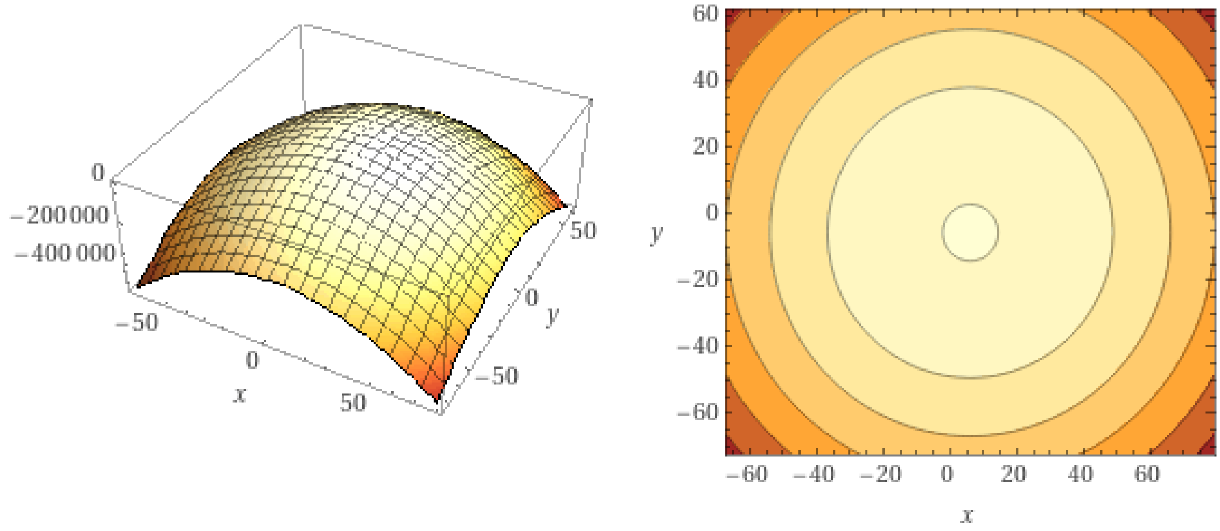

Fig. 8. Graphic distribution, as 3D model and isoquants, of Y_P in relation to R (x-axis) and G (y-axis), Alex wheat cultivar (images captured on May 28)
Source: original graphs generated based on experimental data.

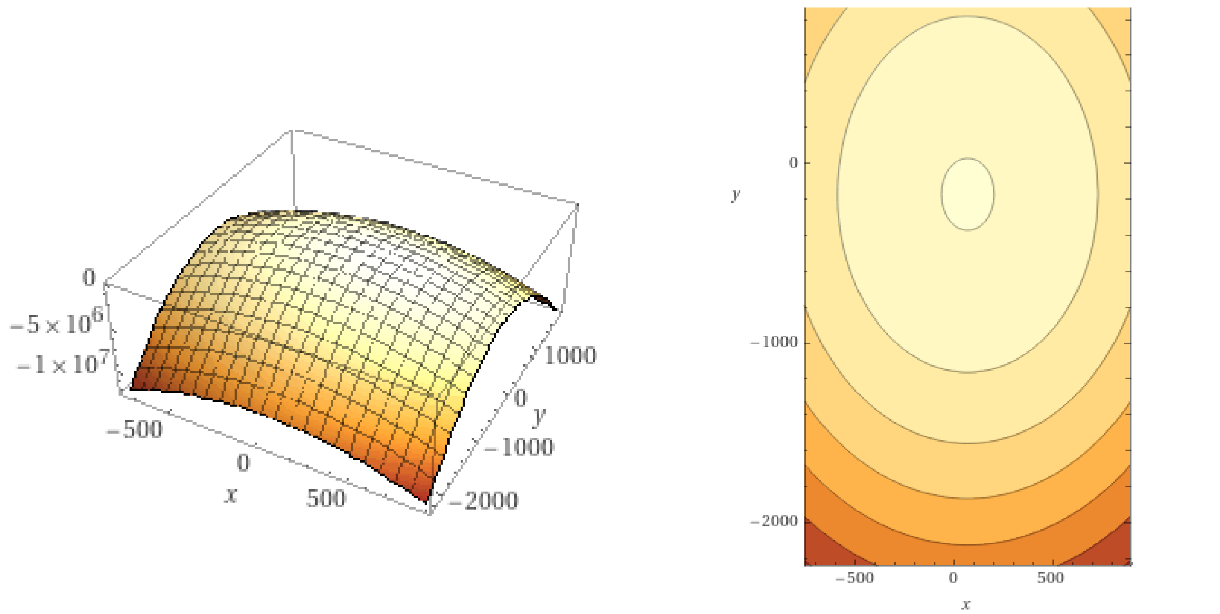

Fig. 9. Graphic distribution, as 3D model and isoquants, of Y_P in relation to R (x-axis) and G (y-axis), Alex wheat cultivar (images captured on Julay 01)
Source: original graphs generated based on experimental data.

The assessment of the prediction certainty of the production predicted (Y_P) in relation to the R and G values, obtained from the analysis of digital images, was made based on the R^2, F-test and RMSEP values, relation (1). The values obtained are presented in Table 3.
In addition, the predictive error was taken into account, as an average value, on each experimental variant, in relation to the real production (Y) (Figure 10).

Table 3. Values of the parameters R^2, F-test and RMSEP, in relation to the predicted production, based on R and G, Alex wheat cultivar

Statistical Parameters	Date taken of the images			
	April 29	May 13	May 28	July 01
R^2	0.997	0.993	0.990	0.968
F-test	560.2515	172.206	125.5518	36.9821
RMSEP	183.5859	330.3418	386.3834	703.9887

Source: Own data resulting from the analysis of experimental data.

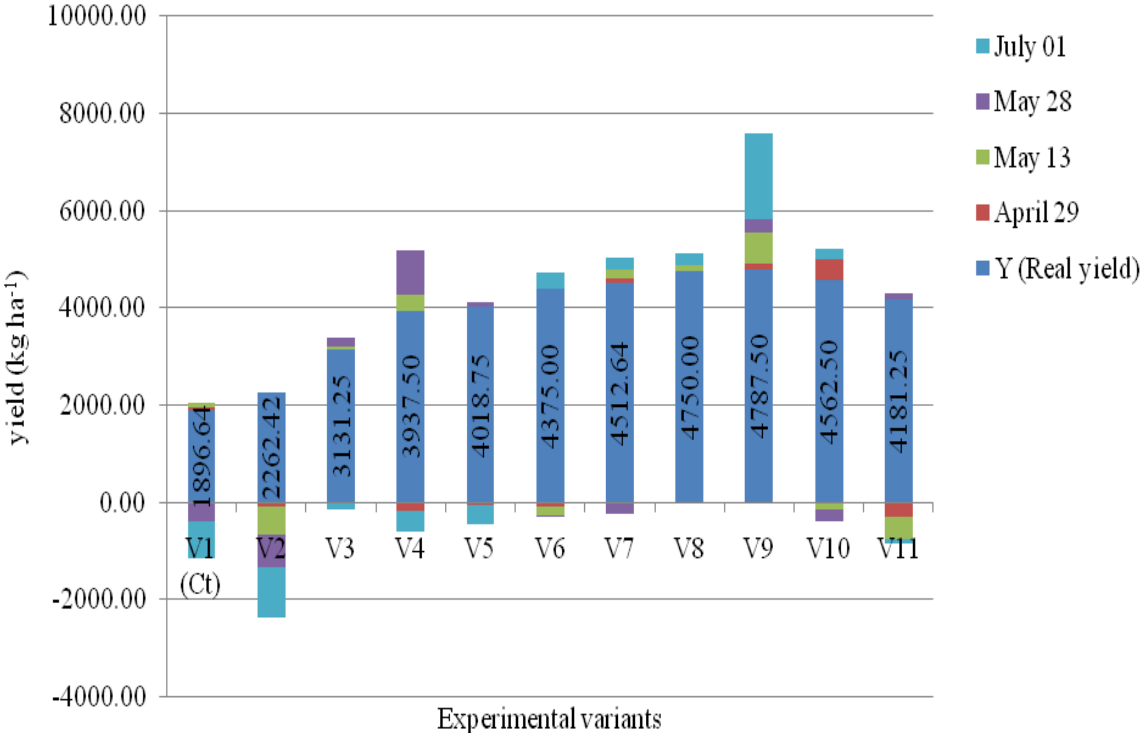

Fig. 10. Graphical representation of the real yield (Y) and of the estimation errors in relation to the date of taking over the digital images
Source: original graphs generated based on experimental data.

From the overall analysis of the values of the determined safety parameters, it was found that it was possible to predict the wheat production (Y_P) based on the analyzed images, regardless of the time of sampling.
However, a comparative analysis of the values of the respective parameters (Table 2), found the variation of the estimated accuracy of the production Y_P, but in conditions of statistical security for all cases.
Overall, the higher safety was recorded based on the images from April 29, and subsequently, as a result of a variation of the plants, the prediction accuracy was reduced, but in conditions of statistical safety (R^2=0.997 to R^2=0.968).
RMSEP confirms the higher accuracy of production prediction based on parameters R and G, the lowest value being recorded for the calculation based on images from April 29 (RMSEP = 183.5859).
A practical advantage of this approach is given by the fact that in the respective vegetation phase, plant nutrition can be corrected by supplementing high amounts of nitrogen fertilizers (the mineral element considered in this study).
Subsequently, in more advanced phases of vegetation, plant nutrition can be corrected, but with lower doses of fertilizers and, usually, with foliar application.
Fertilizers are an important factor in increasing agricultural production, and fertilization has been studied in wheat crops in relation to different genotypes, soil and climate conditions, fertilizers, methods and techniques of application, quantitative and quality indices of production [49], [50], [32], [59], [65].
Nitrogen is the nutrient that contributes most consistently to plant growth and development, and to the formation of agricultural production.
Compared to the control variant (V1) for all fertilized variants, a variation of the studied colour parameters (RGB) was found, associated with a better state of plant nutrition.
The nutritional status was reflected in the plant density, the biomass achieved, and the light reception properties, and this was highlighted in the RGB colour parameters

studied.

Estimation of production in agricultural crops is of interest and different estimation models have been developed in relation to different influencing factors [61], [30], [23], [63].

Mathematical models, based on different types of equations (polynomials, logistics, etc.), are important because they facilitate the analysis of multiple data series, summations and the calculation of optimal values in relation to the variables taken into account [53], [35], [31], [55], [57].

In the present study, the regression analysis facilitated the obtaining of a mathematical model, such as equation (2), which facilitated the estimation of wheat production, Alex cultivar, based on the colour parameters R and G taken into account.

At the same time, a variation of the precision safety was found, in relation to the moment of taking the images, but the statistical safety was maintained.

With the introduction and promotion of techniques based on satellite, aerial, or terrestrial imaging, the advantages of crop monitoring were obvious, and this facilitated the predictive modeling and estimation of total biomass production or useful production, in high precision conditions [24], [16], [43].

The present study used spectral information, the RGB system, from aerial imagery to obtain models for wheat production estimation, and contributed to the development of the database and information for farm-level crop management.

Through the data obtained, it provides researchers and farmers with information and methods of approach in order to monitor the crops and facilitate real-time decisions.

CONCLUSIONS

Differentiated nitrogen fertilization generated a specific variation of RGB parameters, as spectral information associated with aerial images.

The regression analysis facilitated the estimation of wheat production, Alex cultivar, based on RGB colour parameters obtained from aerial images, taken at different times by vegetation.

Compared to the date the images were taken, the production estimation safety showed different levels of accuracy, but in statistical safety conditions. Images from earlier stages of vegetation facilitated production estimation with higher statistical certainty.

The data obtained can be integrated into decision models for wheat crop management and can be extended to other agricultural crops.

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BEHAVIOUR OF SOME OAT LINES TO THE ATTACK OF THE FUNGUS *BLUMERIA GRAMINIS* (D. C.) F. SP. A*VENAE* EM. MARCHAL

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Abstract

Blumeria graminis (DC) f. sp. avenae Em. Marchal (powdery mildew) fungus is considered an important foliar pathogen for oat that can affect the yield and the quality, mainly in the years with cool and humid weather. Climate conditions in the spring of 2019 in Banat Plain (Lovrin area) were favourable for infections. The research objective was to identify the oat lines with good resistance to powdery mildew. Thus, there were monitored 15 oat lines. The research method applied was the calculation of the incidence, severity and infection degree of the fungus. The relative resistance of the oat lines was set by comparing the infection degree of the tested material with the oat line that had the highest sensitivity to the attack of the pathogen. The frequency of the plants with powdery mildew symptoms was comprised between 5% and 100%. The infection severity had values between 10% and 70%. The most resistant oat line from the experience was 2509 and the most sensitive was 2515. The resistant lines could be used to the creation of some productive oat varieties with a good resistance to the attack of powdery mildew.

Key words*: Blumeria graminis, relative resistance, disease severity, winter oat*

INTRODUCTION

During the last twenty years the Agricultural Revolution has been associated with new cropping technologies, technical and genetically progress, machinery revolution, a better management of biotic and abiotic constrainers, faster access to the information of the farmers, global population increase and a higher demand for food supply worldwide [1][2][3][4][5][6][9][17][18][19][20][28][29][31][32][37][38][39].

The etiologic agent of oat powdery mildew is the fungus *Blumeria graminis* (DC) f. sp. *avenae* Em. Marchal framed in the regnum *Fungi*, phylum *Ascomycota*, class *Leotiomycetes*, order *Erysiphales*, family *Erysiphaceae*, genus *Blumeria*, species *avenae*. *Blumeria graminis,* produces the powdery mildew disease in wheat, barley, rye and oat and in many cultivated and spontaneous grasses species (*Poaceae*). According with Eliade (1990), the polyphagia of this fungus in only apparent in reality because in the framework of the species *B. graminis* exist special forms (*f. sp.*) and physiological strains or pathotypes strictly specialized [10]. According with [16] and [27] exist eight forms specialized on species of *Triticum* (f. sp. *tritici*), *Hordeum* (f. sp. *hordei*), *Secale, Avenae* (f. sp. *avenae*), *Poa* (f. sp. *poae*), *Bromus* (f. sp. *bromi*), *Dactylis* (f. sp. *dactylidis*) şi *Agropyron* (f. sp. *agropyri*). Every specialize form has a limited infection capacity to only one host species [33][45].

Blumeria graminis is an ectoparasitic bound fungus that forms a branched white mycelium on the surface of the attacked organs and sends the branched haustoria in the parasite cells. On the mycelium are forming the asexual anamorph fructification organs, respectively the conidiophores with conidia (conidian form or anamorph f. c. *Oidium monilioides* Lk.) and the teleomorph sexual ones, respectively the cleistothecia [10][30][43].

This fungus attacks in the beginning the basal leaves of oat and then is spreading to sheats and stems. Powdery mildew covers entire plant in favourable climate conditions. On the surface of the infected organs are forming white – light greyish mycelium patches with felty aspect and later the mycelium became powdery and coloured in grey. The leaves covered with mycelia will dry later [8][34][42]. The severe infections in early stages of development of the oat plants can affect the tillering and later the size of the inflorescences. The infections that appear later in the vegetation period and reach the flag leaf can affect the grain filling and affect in general the normal development of the plants [8][42].

According with [15] powdery mildew is one of the most harmful disease of oat, mainly in the areas with cool and wet climate. The yield loses from the years favourable to the disease can reach even 32% [14]. Other authors underlined that the yield loses produced by powdery mildew varies between 5% and 30% [11][46].

In Banat Plain powdery mildew can appear with high frequency and intensity in winter oat only in the years with cool and wet spring [42].

The factors that are predisposing the oat to the powdery mildew disease are similar to the ones that determinate the appearance of the disease in the other cereals. In general, the factors that favour the disease are high densities, excessive nitrogen fertilisation, climate and the early falling of the plants [30][34][42].

The resistance of the oat genotypes to the attack of the fungus *Blumeria graminis* can be evaluated by comparing the disease attack severity with the severity level of the disease of the most sensitive genotype analysed. Thus, the relative resistance of a variety varies from 0 (highly sensitive) to 1 (completely resistant). Zadoks (1972b) recommends the comparison with the infection degree of the tested biological material that manifests the greatest susceptibility, to eliminate the environment influence on the resistance [48]. Estimation of the intermediate resistance levels in the case of the pathogens is recommended to be done by a monocyclic test and a polycyclic test [7][48].

According with [36], oat powdery mildew can be controlled difficultly using prevention methods and even chemical ones. The most efficient control method is the use of resistant varieties [23][24][25].

There were identified and characterized eight genes for the oat resistance to powdery mildew until nowadays. In the plant inbreeding programs are used and present in oat varieties most often the genes Pm1, Pm3 and Pm6 [26][40]. Hsam *et al.* (2014) showed that in Europe the gene Pm7 is used mostly in the oat inbreeding programmes without naming the varieties that are having the gene [13]. Okon (2015) shows that the resistance determined by the genes Pm1, Pm3 and Pm6 isn’t efficient in the case of the new strains of the pathogen [22]. The same is happening in the case of the gene Pm7. Now, only the gene Pm4 provides the best resistance to the oat powdery mildew. With all of these, having in view the increased variability of the *Blumeria graminis* populations, there is the risk to get lost this resistance in the following years too. That is why in the oat inbreeding programmes must to be identified new powdery mildew resistance sources [12][26][41].

In this work were analysed 14 oat genotypes from the point of view of the response to the attack of the fungus *Blumeria graminis* f. sp. *avenae*. The tested varieties were compared with the control variety Sorin that had proved to be the most sensitive to the powdery mildew attack. The tested genotypes were monitored in conditions of natural infection because powdery mildew appears every year in the oat crops from Banat, with different attack frequencies and intensities. The purpose of this research is to identify the genotypes that manifest resistance to *Blumeria graminis* attack in a year with the spring and first summer month characterized by a cool and moist weather, respectively the year 2019.

MATERIALS AND METHODS

The comparative and competitive trial consisted in fifteen oat genotypes placed in the territory of the Agricultural Research and Development Station Lovrin (ARDS Lovrin) (Western Romania) in the field plot dedicated to the oat inbreeding. The plots were placed randomized using the Latin rectangle with three replicates. The size of every plot was 10 m^2 (1 m x 10 m) with pathways between every plot having 0.40 m width. The pathways between the replicates have 2.5 m width.

The data regarding the fungus attack degree were collected at every 10 days in the interval May – June 2019. The incidence of the attack was set using the metric frame (50 cm x 50 cm) considering the relative value of the attacked plants number in relationship with the total number of plants or organs analysed.

The attack degree was calculated according with the formula, respectively as the product between the incidence and severity of the disease divided to 100. Disease severity was assessed on a 0 – 9 scale [44].

The relative resistance of the analysed genotypes was assessed on a scale from 0 to 1, by comparing the infection degree of the tested genotype with the same feature of the genotype that manifest the greatest sensitivity to the pathogen [47].

The reaction of the genotypes to the pathogen *Blumeria graminis* was set using the three resistance levels: resistant (R) between 0 – 20% foliar surface affected by disease; intermediary (I) or medium resistant (MR) between 20 – 50% of the foliar surface affected by disease; susceptible (S) more than 50% of the foliar surface affected by the pathogen [21]. Climate data from the analysed period were collected from the meteorological station of ARDS Lovrin.

The statistical analysis of the results (ANOVA, Pearson's and Spearman's correlations) was done using the statistics software JASP 2.0.

RESULTS AND DISCUSSIONS

In Lovrin area the climate from the period March - April 2019 was humid, mostly in the second half of the analysed time interval. In March the rainfalls amount was 15 mm, respectively with 17.3 mm less than the multiannual average value for this month that is 32.3 mm.

The rainfall deficit was registered in April too, in comparison with the multiannual average rainfall amount (34 mm) the registered deficit was 8.7 mm. Entire rainfall amount from April was distributed in the second and third decade. From the second decade of April toll to the end of June the rainfalls were almost continuous, their distribution in time being relatively evenly (Figure 1).

The months May and June were characterised by a cool and humid climate in first part and warmer in the second part of the interval. The rainfalls were far exceeded the multiannual of the months May and June. The rainfall excess from May was 34.7 mm and in June 19.9 mm (Figure 1).

Entire rainfall amount from the interval March – June 2019 was 229 mm, respectively with 28.6 mm greater that the multiannual average of the three months. As rate, 44% from the rainfall amount that had to be in a year, respectively 520.6 mm was registered in that interval of the year 2019 (Figure 1).

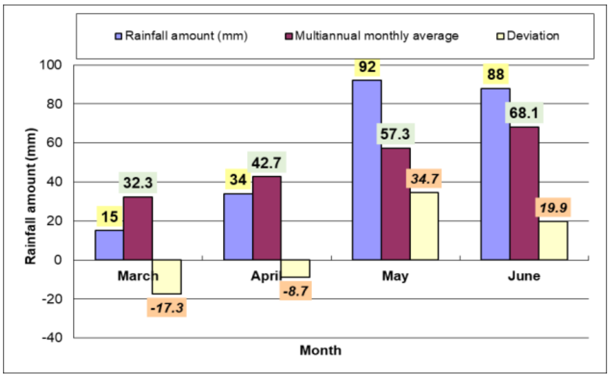

Fig. 1. Rainfall amount from Lovrin during March – June 2019 in comparison with multiannual monthly averages

Source: Original graph generated based on the climatic data (precipitation) registered at the Meteorological Station of ARDS Lovrin.

From the point of view of the thermal regime there were registered deviations from the multiannual monthly average (Figure 2).

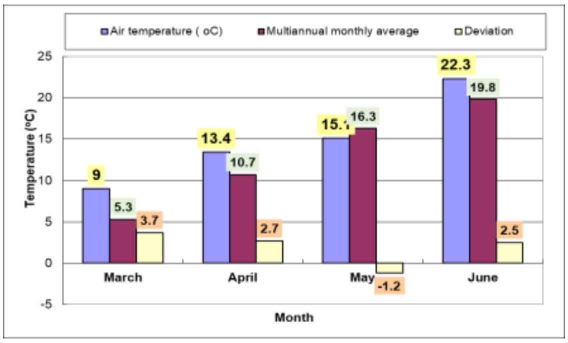

Fig. 2. Thermal regime from Lovrin during March – June 2019 in comparison with multiannual monthly averages
Source: Original graph generatedl based on the climatic data (temperatures) registered at the Meteorological Station of ARDS.

Temperatures in the months March, April and June had positive deviations, overpassing the multiannual monthly averages with 3.7 ^{o}C in March, 2.7 ^{o}C in April and 2.5 in June. In May, the monthly average temperature was lower with 1.2 ^{o}C in comparison with the multiannual average value of the month for Lovrin area (Figure 2).
On this climatic background powdery mildew appeared in the trial formed from the most valuable descendances of 15 genotypes of winter oat (one variety and 14 lines). The variety Sorin was chosen as control because it was proved to be the most sensitive to powdery mildew attack. This variety was created the Agricultural Research and Development Station Lovrin.
The attack frequency of the powdery mildew attack in the analysed genotypes was comprised between 2.66 and 100%. In 12 genotypes the frequency of the plants with powdery mildew symptoms was 100% at the last data collection. The lines2508, 2509 and 2510 were highlighted by lower attack frequencies (F% = 2.66 - 36%). The lowest incidence was registered in the line 2509 (F = 2,66%) (Figure 3).
The amplitude of the attack severity (I%) on plant was comprised between 1.66% (line 2509) and 60% (control variety Sorin). Eight lines of winter oat from the trial had registered a lower severity of the attack comprised between 1.66% and 20% (the lines 2505, 2506, 2507, 2508, 2509, 2510, 2511 and 2513). In the other lines the attack severity was comprised between 36-60% (Figure 3).

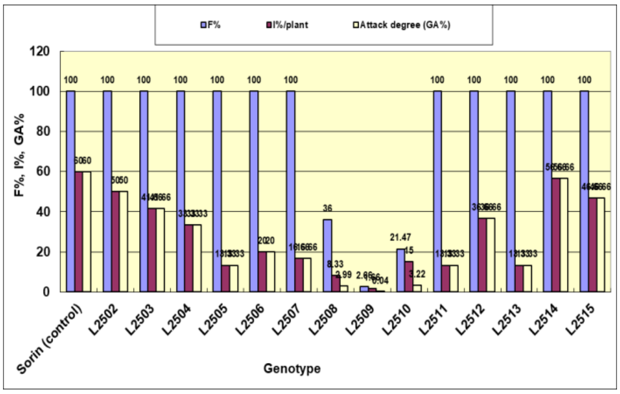

Fig. 3. Diagram of frequency and severity of powdery mildew (*Blumeria graminis* f. sp. *avenae*) attack in the winter oat lines from the comparative and competitive trial from 2019
Source: Original graph generated based on the calculated experimental values

The obtained attack degree was similar with the attack severity (I%) in the case of 12 lines from the total 15 analysed, because the frequency of the infected plants was 100%. The oat lines with low frequency and severity have presented low attack degree, respectively 0.04% in line 2509, 2.99% in line 2508 and 3.22 in line 2510 (Figure 3).
Severity of the infection of the levels of the plants was set separated by the other investigations with the purpose to highlight the oat lines at that the pathogen had reached the flag leaf. There were analysed the four leaves below the inflorescence starting with the flag leaf.
Analysing the obtained results following the observations there was noticed that the flag leaf (Leaf 1) was infected only in a single oat line, respectively 2515. The foliar surface of this line was covered in a 70% rate with powdery mildew mycelia. Leaf 2 was covered with mycelia only in four lines from the total of 15 and the attack intensity was comprised between 10% (2502) and 50% (2503).
Leaf 3 was affected by the pathogen in rates comprised between 10% and 75% in 12 lines from the trial. Only in three lines the leaf 3 had remained healthy (2505, 2508, 2509).
Leaf 4 was covered with powdery mildew mycelium in different rates comprised

between 0 (line 2509) and 100% (line 2514). The average severity of the infection of the leaves from the superior level is presented in Figure 4.

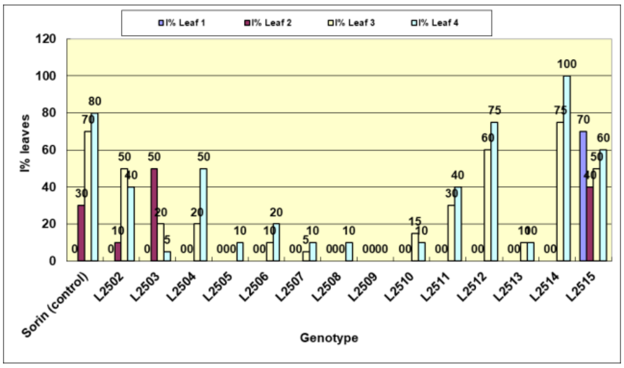

Fig. 4. Diagram of frequency and severity of powdery mildew (*Blumeria graminis* f. sp. *avenae*) attack of the leaves from the upper level of the winter oat lines from the comparative and competitive trial from 2019
Source: Original graph generated based on the calculated experimental values

In the control variety Sorin, the leaf 4 was 80% covered with powdery mildew mycelia. Line 2509 is highlighted by the resistance to the pathogen. In this line, the fungus wasn't reached the upper level of the plants and the only symptoms registered were at the base of the plants as very small mycelium patches. The evolution of the fungus in this line was stopped surely by the genetic resistance mechanisms.

In 6 lines from the trial the infection on the leaf 4 was lower than 10% (2503, 2505, 2507, 2508, 2510, 2513).

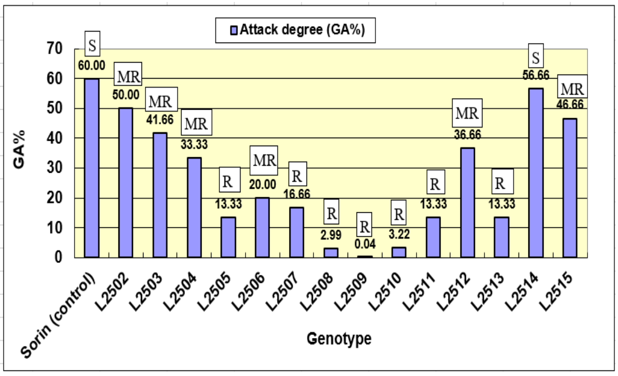

Fig. 5. Response of the winter oat lines from the comparative and competitive trial to the powdery mildew attack in 2019
Source: Original graph generated based on the calculated experimental values.

The response of the fifteen oat lines to the powdery mildew attack was associated using two assessment scales regarding the resistance to the pathogens. According to the scale used by [21], 7 lines from the trial were reacted as resistant (2505, 2507, 2508, 2509, 2510, 2511, 2513) and 6 lines medium resistant (2502, 2503, 2504, 2506, 2512, 2515). The control variety Sorin and the line 2514 have showed increased sensitivity to the pathogen (Figure 5).

The relative resistance (RR) calculated using the formula of Zadocks (1972b) had classified more severe the response of the oat lines to the powdery mildew attack (Figure 6).

Thus, according with the obtained results using this method only three lines were considered as resistant (2508, 2509 și 2510). The attack frequency and severity were very low in these lines. Five lines from the trial had manifested medium resistance (2505, 2506, 2507, 2511, 2513). Low sensibility to the pathogen (SR) was registered in the lines 2503, 2504 and 2512. The line 2515 was characterized as sensitive to the pathogen (S). The most sensitive lines to the powdery mildew attack were the genotypes 2514, 2502 and the control variety Sorin, the response being as the most sensitive (FS) genotype from the trial with RR between 0 and 0.2.

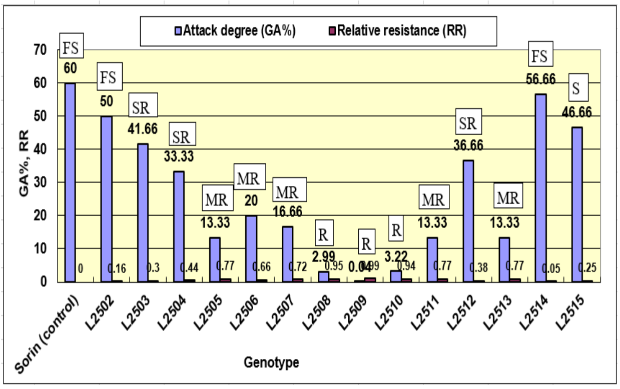

Fig. 6. Relative resistance (RR) of the winter wheat genotypes from the comparative and competitive trial to the powdery mildew attack in 2019
Source: Original graph generated based on the calculated experimental values.

Comparing the results regarding the response of the oat lines to the attack of the fungus using the scale of [21] is obvious the fact that it is more permissive compared with the scale proposed by [47], because only two lines are sensitive from this point of view. In the case of the more severe RR scale 7 lines have manifested sensitivity to the pathogen. Both scales are highlighting the special resistance of three winter oat genotypes, respectively 2508, 2509 and 2510. From these lines, the line 2509 presents interest for the following inbreeding programs of the winter oat from the Station of Research and Development for Agriculture Lovrin. The statistical analysis (ANOVA) supports the obtained results. Thus, the effect of the attack intensity (I%) on the analysed genotypes is significant (Table 1). The analysis between the effect of the infection factors (intensity and frequency) and the oat genotypes shows that there is significance from the point of view of the variation of the attack intensity and frequency (Table 2 and Figure 7). The Levene test for the equality of the variances (ANOVA) shows the existence of the signification only in the case of the attack frequency (Table 3).

Table 1. Analysis within the effects of the infection factors with powdery mildew and genotype (ANOVA)

Cases	Sum of Squares	df	Mean Square	F	p
RM attack intensity I%	69457.223	1	69457.223	1459.708	< 0.001
RM I% ✻ Genotype	16592.671	14	1185.191	24.908	< 0.001
Residuals	1427.488	30	47.583		
Note. Type III Sum of Squares					

Source: Own calculation based on experimental data.

Table 2. Analysis between within the effects of the infection factors with powdery mildew and genotype (ANOVA)

Cases	Sum of Squares	df	Mean Square	F	p
Genotype	46255.239	14	3303.946	60.216	< 0.001
Residuals	1646.055	30	54.868		
Note. Type III Sum of Squares					

Source: Own calculation based on experimental data.

Table 3. Levene's test for equality of variances (ANOVA)

	F	**df1**	**df2**	**p**
Blumeria graminis attack intensity (I%)	1.244	14	30	0.297
Blumeria graminis attack frequency (F%)	8.016	14	30	< .001

Source: Own calculation based on experimental data

Table 4. Post-hoc comparisons between the control oat variety Sorin with the analysed lines (ANOVA)

Genotype	Mean Difference	95% CI for Mean Difference		SE	t	p_{tukey}	
		Lower	Upper				
Sorin	-	-	-	-	-	-	-
2502	5.000	-11.762	21.762	4.277	1.169	0.996	
2503	9.167	-7.595	25.929	4.277	2.143	0.698	
2504	13.333	-3.429	30.095	4.277	3.118	0.168	
2505	23.333	6.571	40.095	4.277	5.456	< 0.001	***
2506	20.000	3.238	36.762	4.277	4.677	0.004	**
2507	21.667	4.905	38.429	4.277	5.066	0.001	**
2508	57.833	41.071	74.595	4.277	13.523	< 0.001	***
2509	77.800	61.038	94.562	4.277	18.192	< 0.001	***
2510	61.762	45.000	78.524	4.277	14.442	< 0.001	***
2511	23.333	6.571	40.095	4.277	5.456	< 0.001	***
2512	11.667	-5.095	28.429	4.277	2.728	0.336	
2513	23.333	6.571	40.095	4.277	5.456	< 0.001	***
2514	1.667	-15.095	18.429	4.277	0.390	1.000	
2515	6.667	-10.095	23.429	4.277	1.559	0.955	
*** p <0 .05, ** p < 0.01, *** p < 0.001**							

Source: Own calculation based on experimental data.

Statistical analysis (ANOVA, post-hoc p_{tukey}) compares the oat variety Sorin (control) with the other lines from the winter oat trial shows the existence of the highly significant differences of six lines in comparison with the control (*** p < 0.001), respectively the lines 2505, 2508, 2509, 2510, 2511 and 2513. In the case of two lines from trial (2506 and

2507) the differences compared with the control were also significant (** p < 0.01). For the remained lines from the trial weren't found significant differences in comparison with the control (Table 4). The oat lines that have registered statistically significant differences they were reacted as medium resistant (2505, 2506, 2507, 2511 and 2513) and resistant (2508, 2509 and 2510) to the powdery mildew attack.

Table 5. Correlation (Pearson's *r* and Spearman's *rho*) and *p*-values matrix among the analysed variables of the infection with powdery mildew in winter oat

Variable		***B. graminis* I% / plant**	***B. graminis* F%**	***B. graminis* I% / leaves**	**Attack degree AD%**	**Leaf 1**	**Leaf 2**	**Leaf 3**	**Leaf 4**
B. graminis F%	Pearson's r	0.552 *	—						
	p-value	0.033	—						
	Spearman's rho	0.582 *	—						
	p-value	0.023	—						
B. graminis I% / leaves	Pearson's r	0.826 ***	0.455	—					
	p-value	< 0.001	0.088	—					
	Spearman's rho	0.755 **	0.463	—					
	p-value	0.001	0.082	—					
Attack degree AD%	Pearson's r	0.989 ***	0.632 *	0.819 ***	—				
	p-value	< 0.001	0.012	< 0.001	—				
	Spearman's rho	0.978 ***	0.697 **	0.749 **	—				
	p-value	< 0.001	0.004	0.001	—				
Leaf 1	Pearson's r	0.265	0.131	0.258	0.264	—			
	p-value	0.339	0.641	0.353	0.341	—			
	Spearman's rho	0.248	0.133	0.250	0.248	—			
	p-value	0.372	0.637	0.369	0.372	—			
Leaf 2	Pearson's r	0.570 *	0.262	0.262	0.565 *	0.515 *	—		
	p-value	0.027	0.346	0.345	0.028	0.050	—		
	Spearman's rho	0.635 *	0.295	0.338	0.635 *	0.476	—		
	p-value	0.011	0.286	0.218	0.011	0.073	—		
Leaf 3	Pearson's r	0.884 ***	0.437	0.950 ***	0.869 ***	0.234	0.321	—	
	p-value	< 0.001	0.103	< 0.001	< 0.001	0.402	0.243	—	
	Spearman's rho	0.857 ***	0.501	0.941 ***	0.844 ***	0.218	0.440	—	
	p-value	< 0.001	0.057	< 0.001	< 0.001	0.435	0.100	—	
Leaf 4	Pearson's r	0.790 ***	0.458	0.967 ***	0.789 ***	0.220	0.125	0.933 ***	—
	p-value	< 0.001	0.086	< 0.001	< 0.001	0.431	0.656	< 0.001	—
	Spearman's rho	0.718 **	0.528 *	0.880 ***	0.734 **	0.252	0.135	0.847 ***	—
	p-value	0.003	0.043	< 0.001	0.002	0.364	0.630	< 0.001	—

* p <0 .05, ** p < 0.01, *** p < 0.001

Source: Own calculation based on experimental data

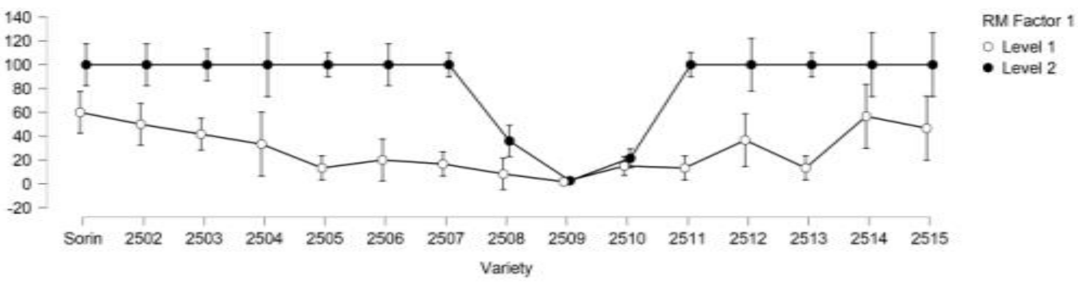

Fig. 7. Descriptive plot representing powdery mildew attack intensity I% (Level 1) and attack frequency F% (Level 2) in winter wheat trial
Source: Own research.

The obtained results were statistically processed using the correlation coefficients Pearson (*r)* și Spearman (*rho*), searching for the identification of some interrelations amongst the parameters of the powdery mildew attack on the winter oat. In Table 5 is presented the matrix of the Pearson's *r* and Spearman's *rho* and the significance levels (*p-value*).

According with the obtained results there weren't identified great differences among two types of correlation coefficient used, the obtained values being quite similar in almost all the correlations except two cases (Table 5). In the first case the correlation was significant for Pearson *r* between the powdery mildew attack on leaf 1 and leaf 2 (*r* = 0.515*) and in the case of Spearman *rho* wasn't significant; and the second the correlation found was significant with Spearman *rho* between F% and leaf 4 (*rho* = 0.528*), but for Pearson *r* wasn't significant. Thus, after the statistical analysis there were identified many correlations. The attack intensity (I%) was positively correlated with the attack frequency (F%) (*r* = 0.552*; *rho* = 0.582*), with the average intensity of the attack on leaves (*r* = 0.826***; *rho* = 0.755**), with attack degree (GA%) (*r* = 0.989***; *rho* = 0.978***), with the attack intensity on leaf 2 (*r* = 0.570*; *rho* = 0.635*), with attack intensity on leaf 3 (*r* = 0.884***; *rho* = 0.857***) and with the attack intensity on leaf 4 (*r* = 0.790***; *rho* = 0.718**). The attack frequency of the powdery mildew was correlated with attack degree (GA%) (*r* = 0.632*; *rho* = 0.697**) and attack intensity on the leaf 4 (*rho* = 0.528*). Attack intensity on leaves was correlated positively with attack degree (GA%) (*r* = 0.819***; *rho* = 0.749**), attack intensity on the leaf 3 (*r* = 0.950***; *rho* = 0.941***) and the attack intensity and leaf 4 (*r* = 0.967***; *rho* = 0.880**). Attack degree of the fungus was also positively correlated with the attack intensity on leaf 2 (*r* = 0.565*; *rho* = 0.635*), with attack intensity on leaf 3 (*r* = 0.869***; *rho* = 0.844***) and attack intensity on the leaf 4 (*r* = 0.789***; *rho* = 0.734**). Other positive correlations obtained here were between the attack intensity on leaf 1 with attack on the leaf 2 (*r* = 0.515*) and between the attack intensity on the leaf 3 with the attack on the leaf 4 (*r* = 0.933***; *rho* = 0.847***).

The obtained value for the multivariate normality Shapiro - Wilk was 0.284, respectively $p<0.001$. It shows that the variability of the correlated variables is normal (Table 6).

Table 6. Shapiro - Wilk test for multivariate normality of the correlated variables

Shapiro-Wilk Test for Multivariate Normality	
Shapiro-Wilk	**p**
0.284	< 0.001

Source: Own calculation based on experimental data

In the program for winter oat inbreeding from the Agricultural Research and Development Station Lovrin an important purpose is the obtaining of resistant genotypes to the attack of the specific pathogens. From all the pathogens that attack oat *Blumeria graminis* f. sp. a*venae* is considered very important and dangerous due to the yield significant loses determined, even 40% according with some researches, mainly in the years favourable for this pathogen [35].

Powdery mildew is very common in winter oat crops in Banat Plain, western Romania.

According with the results regarding the relative resistance 21.4% from the winter oat lines analysed were resistant to powdery mildew, 35.7% were manifested medium resistance to the pathogen, 21.4% were low resistant, 7.1% were sensitive and 14.3 very sensitive. Among the resistant lines was highlighted the line 2509 due to its great resistance to powdery mildew, being the only one from the trial where the leaves weren't attacked, the disease showing very small patches on the plants base that had stopped from evolution. This line presents interest for the inbreeding and can be used for the creation of new varieties of winter wheat at Agricultural Research and Development Station Lovrin.

In the future the researches will be oriented to the identification of the genes for resistance for powdery mildew from the oat lines used for inbreeding. Creation of new varieties with resistance to powdery mildew is important in the management of the pathogen, there being known that the most efficient method for the prevention of the appearance of the disease is the use of biologic material with high genetic resistance.

CONCLUSIONS

The comparative and competitive trial with 14 winter oat lines and a variety was set with the purpose to select resistance sources to the attack of the fungus *Blumeria graminis* f. sp. *avenae*. From the analysed lines in the conditions of natural infection only three have presented high relative resistance, respectively the lines 2508, 2509 and 2510. The line 2509 there was identified a great resistance to the powdery mildew attack. This line will be used in the future for the creation of new varieties. In the future are demanded researches of genetics for the identification of the genes for resistance to powdery mildew (Pm) from the winter oat lines from the Agricultural Research and Development Station Lovrin.

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QUALITY MANAGEMENT OF THE WHEAT BLENDING, IN ORDER TO IMPROVE THE TECHNOLOGICAL PROPERTIES OF THE FLOURS OBTAINED IN THE MILLING PROCESS OF THE ROMANIAN WHEAT VARIETIES

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Abstract

Following the demand of the bakery industry to diversify the range of foods, it can be said that improving the quality parameters of flours has become a necessity from both the supplier and the beneficiary. This research is based on the demonstration that the knowledge of quality indicators as well as alveographic properties are necessary in calculating the mixing percentages of two or more batches of wheat with different quality properties. The individual grinding of three different wheat batches, from three suppliers with different geographical locations (Agroind Oradea, Ameropa Olari and Merpano Săcălaz), was performed. The adequate correlations between main physico-chemical parameters of the wheat grain and the alveographic parameters of the flour obtained lead to the technological properties suitable for bakery or pastry products, fully fulfilling the satisfaction of consumer requirements.

Key words*: *wheat blending, quality management, quality indicators

INTRODUCTION

The quality characteristics of wheat differ from one supplier to another and are directly influenced by a number of intrinsic and extrinsic factors, such as: climatic conditions, wheat treatment, wheat conditioning, storage and storage conditions [6].

The variation of wheat quality represents a real problem in obtaining flours, therefore it is absolutely necessary to determine the quality of the physical and chemical properties of wheat batches in order to orient the flour obtained to the appropriate bakery and pastry products and establishing the need for breeders both in terms of quantity and quality [5]. The rheological analysis of the dough provides valuable information about the behavior of the flour in different phases of the processes of obtaining bakery and pastry products [7]. Between the main physico-chemical parameters of the wheat (such as organoleptic properties, moisture, hectoliter mass, falling number, wet gluten content) and the alveographic parameters of the flour obtained, there are a large number of correlations that ultimately influence the rheological properties of the dough [8][9].

The batches thus constituted are divided according to the technological properties, in three groups [1]:

- batches that can be ground on their own, but can be used in the mix for improvement batches with poorer qualities;
- batches which can be ground on their own but which cannot be used for mixing, the qualitative indicators of the lot ensuring only the standardized minimum values of final products;
- batches that cannot be ground alone, due to poor technological qualities, but only mixed with high quality batches.

Following blending of two or more batches, with different quality indicators, participating in a well-determined proportion, wheat mixtures are sent to grinding, in order to obtain the quality of the flour required by the beneficiary [3].

Good quality management of wheat batches and wheat grain mixtures leads to high yields in terms of flour production, to the optimization of raw material acquisition costs and to the maintenance of a constant quality of the obtained products [2][11].

MATERIALS AND METHODS

The research was conducted on the Romanian varieties of wheat (Triticum aestivum, ssp. vulgare) Agroind Oradea (Sample 1), Ameropa Olari (Sample 2) and Merpano Săcălaz (Sample 3), harvested in 2020.
The main indicators that are taken into account when making the grinding mixtures, namely: moisture, wet gluten, drop rate, mechanical work and hydration capacity. All these factors converge to obtain grinding batches from which a flour with desired baking properties will be obtained [10].
The three wheat grain samples were previously analyzed using the NIR FOSS INFRATEC 1241 Grain Analyzer for a quick determination of the main indices (protein content, moisture, wet gluten, mechanical work, hectoliter mass) after which each sample was analyzed separately to determine mechanical work by the alveographic method (SR EN ISO 27971/2009), the falling number index by the Hagberg method (SR EN ISO 3093/2007) and wet gluten by the manual method (SR EN ISO 21415-1/2007). The rheological analysis performed with the help of the Chopin alveograph (Alveolink NG) determined the technological qualitative properties of the flours obtained by the individual grinding of three different wheat batches, coming from three Romanian suppliers from different geographical locations.
Following the elaboration of the Grading Form, it is found that there are 3 grades of different qualities.
After qualitative analyses of the 3 samples, wheat mixtures were made in different percentages (using the method of inverse proportions) from the wheat samples of different qualities, which were analyzed to determine the optimal mixture for obtaining a 650 (0.65 % ashes) type flour which is most often used to obtain bread [4]. In order to obtain the desired final product, wheat flour laboratory analyzes were performed according to the standards depicted above.

RESULTS AND DISCUSSIONS

Determining the quality indicators (Fig. 1) is important because after finding them, the unloading and storage of wheat raw material takes place according to the quality and at the same time the price of wheat is established.
Following the analyzes, the different quality of the 3 batches of wheat was highlighted. Based on the mixtures made, 3 types of flour were obtained that can have different industrial directions.

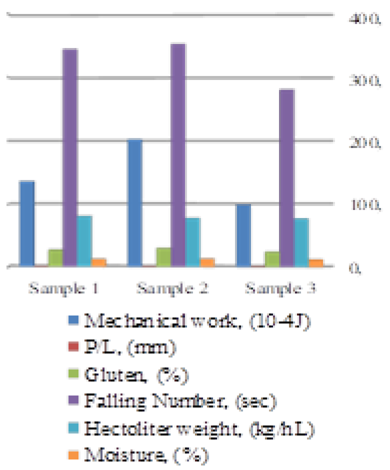

Fig. 1. Results obtained from analyzes performed on wheat- raw material
Source: Own analysis.

From sample 1 of flour (wheat mixture 1) a medium quality flour was obtained which is suitable for use in the bakery industry (Figure 2).
From sample 2 of flour (wheat mixture 2) a high-quality flour was obtained which is suitable for use as flour for specialties that need much greater stability, stronger gluten and high elasticity (Figure 2).
Sample 3 of flour (wheat mixture 3) yielded a lower quality flour which can also be used in the pasta industry, biscuits or any product which does not require very strong gluten, high volume or high elasticity (Figure 2).
The baking test subtly highlighted the differences between the three wheat mixtures, observing small differences in the elasticity of the dough (Photo 1), the volume and porosity of the final product (Photo 2).

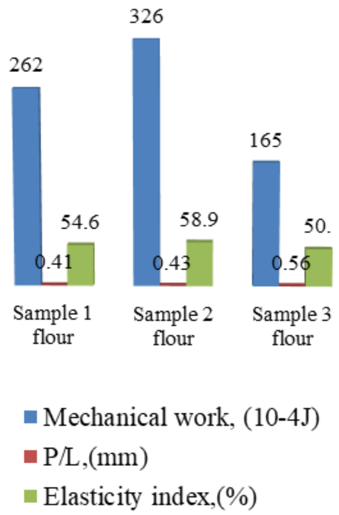

Fig. 2 Qualitative indicators of flour obtained from mixtures of wheat
Source: own analysis.

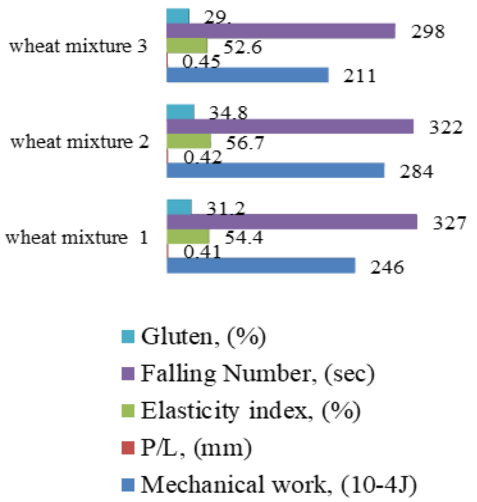

Fig.3. Results obtained from the analyzes performed on the mixtures of the wheat
Source: own analysis.

After analysis of the wheat as raw material, the technical specification of the product was consulted and it was found that it falls within the permissible limits for unloading/storage.

Photo 1. Fermented dough samples obtained from the three grinding mixtures of wheat, from left to right:
-55 minutes fermented dough from wheat mixture 1;
-65 minutes fermented dough from wheat mixture 2;
-50 minutes fermented dough from wheat mixture 3.
Source: own analysis.

Photo 2. Baking test products obtained from the three grinding mixtures of wheat, from left to right: bread from wheat mixture 1, bread from wheat mixture 2, bread from wheat mixture 3
Source: own baking test.

At the end of the analysis of the 3 types of flour obtained, the technical specification of the product was consulted and it was found that wheat mixture 1, which has an average quality, is perfectly suitable for the bakery industry.

CONCLUSIONS

The biological properties of wheat play an important role in its acquisition process.
Grading of raw material wheat is an essential tool in determining the purchase price.
Preliminary analyzes on wheat, performed in the laboratory, give clear and precise information about its quality and facilitate the storage / subdivision process.
Determining the moisture of the raw material is one of the key factors that determine how it is stored.
The quantity and quality of wet gluten give clear information about the properties that the intermediate product will later have, namely the dough.
The hydration capacity is directly influenced by the degree of crushing and the quantity and quality of gluten in the flour, it gives clear information about the stability of the intermediate product, the dough, in the production process.
Determining the mechanical work helps the milling unit to classify both the flour and give

it a purpose and the wheat so that it can be stored according to quality.

The baking test is the key element that shows exactly the behavior of the flour during the technological process.

The storage of wheat in batches according to the quality of each one, leads to the optimization of the working time, of the available storage space and to the facilitation of obtaining the grinding loads.

The importance of wheat blending consists in the fact that following a constant quality of it results a product of a uniform quality and this positively influences the customers' perception on the manufactured product;

The analysis of the wheat mixtures clearly highlighted the importance of the grinding loads in terms of the desire to obtain a flour of a certain target quality for the customer's product.

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MODEL FOR MONITORING AND PRODUCTION PREDICTING IN SUNFLOWER CROP BASED ON SATELLITE IMAGES

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Abstract

The study used imaging analysis to monitor and predict production in sunflower culture under farm specific crop technology. The studied plot was located in the area of Cornesti, Timis County, Romania. Satellite images (Landsat 8) with a resolution of 30 m were taken, at 6 moments (T) between April and September, 2020. NDVI and NBR indices were calculated from the image analysis. The variation of the values of the indices calculated in relation to the time (days) for the studied period was faithfully described by spline models, with the values of the errors calculated $\bar{\varepsilon} = 0.0069$ *in the case of NDVI and* $\bar{\varepsilon} = 0.18945$ *in the case of NBR. The interdependent relationship found between the NDVI and NBR indices was described by a polynomial equation of degree 3, under conditions of* $R^2=0.986$, $p=0.0015$. *Prediction of sunflower production* (Y_P) *based on the values of NDVI and NBR indices was possible under statistical safety conditions* ($R^2=0.998$, $p<0.001$). *The variation of the prediction error, resulted from calculus, was between -0.331 kg* ha^{-1} *in the case of T4 indices (July 28) and 42.722 kg* ha^{-1} *in the case of T6 indices (September 6). The Similarity and Distance Indices (SDI) was used to evaluate the similarity of the vegetation stages on sunflower crop in relation to the moment of the image captures, based on NDVI and NBR indices. The highest degree of similarity was identified between moments T2 and T3 (images from May), in which case SDI = 0.05285. The study provided useful information on the temporal variability of sunflower crop and production prediction in relation to agricultural technology and is the basis of agricultural crop management models.*

Key words: *crop monitoring, model, NDVI, NBR, production prediction, sunflower*

INTRODUCTION

Plant cultivation has undergone permanent improvements, in order to ensure food resources and increase the performance of agro ecosystems, through more adapted biological material [6], [3], [23], [52], more efficient agricultural machinery [17], [9], [25], optimized technologies [24], biotechnologies [10], [51], [30], nanomaterials and nanotechnologies [47], [27], [29], [60], sustainable management of soil resources [28], [50], water regime control [13], plant nutrition management [5], [2], [48], [41], [14], weed control [26], [39], disease and pest control [4], [56], [36].

Crop plants have a variable vegetation period, in relation to plant species (variety, hybrid), ecoclimatic conditions, cropping systems, harvest destination [31], [37].

Monitoring of agricultural crops during the vegetation period is necessary and important for various aspects regarding crop type and crop structure [11], [7], [61], crop variability [65], [45], the state of vegetation and plant nutrition [35], [1], the state of plant health [63], physiological indices and processes [62], [53], [64], productions estimation [16], [34], [22], [55], [57], and harvesting processes [19], [21], [40].

All these elements, previously presented, are necessary and useful for decision-making and different works in the field [8], [46], [33], [43].

Crop monitoring methods have evaluated over time, from simple field observations to the use of satellite, aerial or terrestrial imaging systems on agricultural crops, the use of sensors and dedicated software and applications, including for mobile devices, all while providing new facilities and functionality [18], [42], [59], [49].

The present study evaluated in dynamics a sunflower culture, based on two representative indices NDVI and NBR calculated from spectral information of satellite images, and made a prediction of sunflower production based on those indices.

MATERIALS AND METHODS

The aim of the study was to evaluate in dynamics a sunflower crop, under the conditions of a specific technology of cultivation at farm level, and to find models to describe the temporal variation of the crop and to predict the production based on indices calculated based on satellite images.
The agricultural land with the sunflower crop, with a surface of 59 ha, was in the area of Cornesti, Timis County, Romania, figure 1. During the vegetation, satellite scenes, with a spatial resolution of 30m, were taken, preprocessed and processed, from the Landsat 8 system using the platform http://earthexplorer.usgs.gov/ [54] and the software Erdas Imagine (2014) and ArcGIS v.10.5. Based on spectral information, the NDVI [44] and NBR [20], indices were calculated according to equations (1) and (2).

$$\mathrm{NDVI} = \left(\frac{NIR - \mathrm{Re}\,d}{NIR + \mathrm{Re}\,d} \right) \tag{1}$$

$$\mathrm{NBR} = \left(\frac{NIR - MIR}{NIR + MIR} \right) \tag{2}$$

For the dynamic characterization of the sunflower culture, the satellite images were taken at 6 time moments during the vegetation (April 4 - T1, May 16 - T2, May 21 - T3, July 28 - T4, August 22 - T5 and September 6 - T6).
The dynamics of NDVI and NBR indices is presented in Figure 1.
Generaly, light tones with values higher than 0.1 symbolize lands with high biomass (forests, dry bushes), and dark tones symbolize lands with low biomass (stone or concrete buildings, highways and roads, railways, etc.).

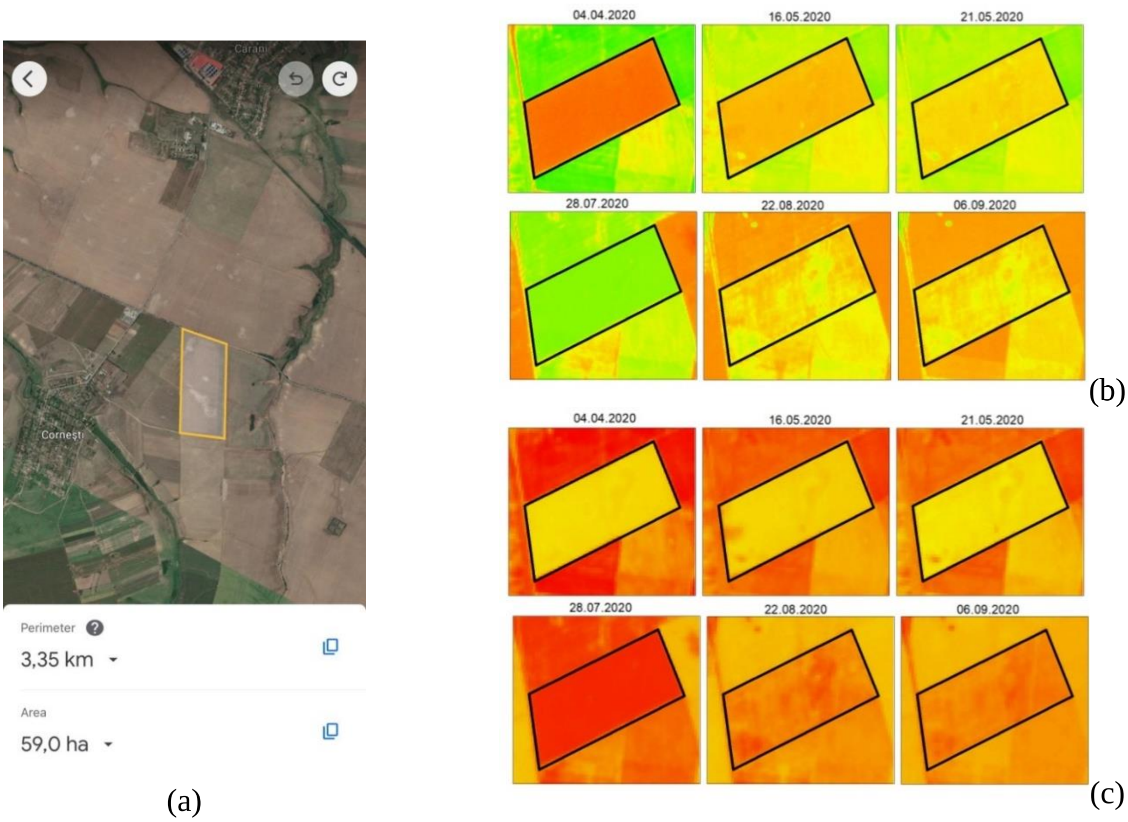

Fig. 1. Location of study area (a) and maps of NDVI (b) and NBR (c) indices for sunflower culture studied
Source: (a) original image captured from Google maps; (b), (c) original images generated on the basis of satellite images.

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As a biological material, the sunflower hybrid P64LE25 was grown.

A suitable culture technology, for the studied area and sunflower culture, was applied; fertilization with complex fertilizers 16:16:16 and ammonium nitrate (200 + 200 kg ha^{-1}); foliar fertilization with macro- and micro-elements, including nitrogen (N) and boron (B) especially; weed control by herbicide; disease control through foliar treatments; use of adjuvant in order to increase the effect of foliar treatments. The harvest was carried out mechanized, and the average production obtained was 3,800 kg ha^{-1}.

The obtained data were analyzed and statistically processed with the mathematical module from EXCEL and the PAST software [12]. The 3D and isoquants graphics were generated with Wolfram Alpha (2020) [58].

RESULTS AND DISCUSSIONS

Consistent with the purpose of the study, the crop was monitored during the vegetation period based on satellite images, in the Landsat 8 system. Six sets of images were taken, based on which the values of NDVI and NBR indices were calculated. The values of the NDVI and NBR indices, the T moments of taking over the satellite images and the value of the obtained production are presented in Table 1.

Table 1. Technical data with reference to the study done on sunflower culture

Image capture date	Trial	t (days)	NDVI	NBR	Y (kg ha^{-1})
April 4	T1	0	0.191668	-0.040234	3,800
May 16	T2	42	0.217241	0.068693	
May 21	T3	47	0.249321	0.026692	
July 28	T4	105	0.748572	0.753765	
August 22	T5	130	0.360012	0.284486	
September 6	T6	145	0.302153	0.175900	

Source: Original data related to the studied sunflower culture.

In the conditions of the applied technology and of the pedoclimatic conditions of framing the farm and the plot of land, the sunflower culture had normal vegetation.

The ANOVA test confirmed the statistical safety of the data and the presence of the variance in the experimental data set (F>F crit, p <0.001, under Alpha = 0.001 conditions).

The variation of the values of NDVI and NBR indices in relation to the time (t, days) during the vegetation period of the sunflower crop was best described by a smoothing spline model, and the errors were calculated according to equation (3). The values associated with the spline model are presented in Table 2 for the NDVI index, and in table 3 for the NBR index. The graphical distribution of the model is shown in Figure 2 for NDVI and in Figure 3 for NBR.

$$\bar{\varepsilon} = \left(\sum_{i=1}^{n} \varepsilon_i\right) / n = \left(\sum_{i=1}^{n} \left|\frac{ys_i - y_i}{y_i}\right|\right) / n \quad (3)$$

Table 2. Statistical values regarding the NDVI variation in relation to time (t) in sunflower culture, in the study conditions and agricultural technology, resulting from the spline model

Trial image capture		NDVI			
No	x_i	y_i	ys_i	e_i	$I_{i/1}$
1	0	0.19167	0.18848	-0.0166	1.000
2	42	0.21724	0.21907	0.0084	1.162
3	47	0.24932	0.25856	0.0371	1.372
4	105	0.74857	0.71896	-0.0396	3.815
5	130	0.36001	0.39692	0.1025	2.106
6	145	0.30215	0.28699	-0.0502	1.523

$\bar{\varepsilon} = 0.0069$

Source: Original data, obtained from the calculation.

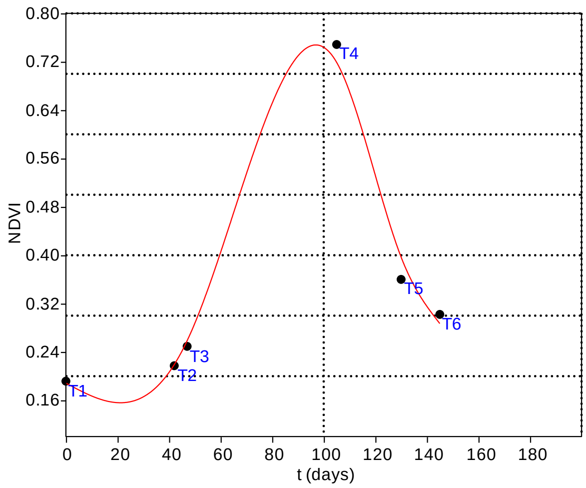

Fig. 2. NDVI in relation to t (days) in sunflower culture, according to the spline model
Source: original graphic obtained from data processing.

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Table 3. Statistical values regarding the NBR variation in relation to time (t) in sunflower culture, in the study conditions and agricultural technology, resulting from the spline model

Trial image capture		NBR			
No	x_i	y_i	ys_i	e_i	$I_{i/1}$
1	0	-0.04023	-0.04143	0.02975	1.000
2	42	0.06869	0.03791	-0.44812	-0.915
3	47	0.02669	0.06806	1.54987	-1.643
4	105	0.75376	0.72287	-0.04098	-17.448
5	130	0.28449	0.31953	0.12317	-7.712
6	145	0.17590	0.16236	-0.07698	-3.919

$\bar{\varepsilon} = 0.1894$

Source: Original data, obtained from the calculation.

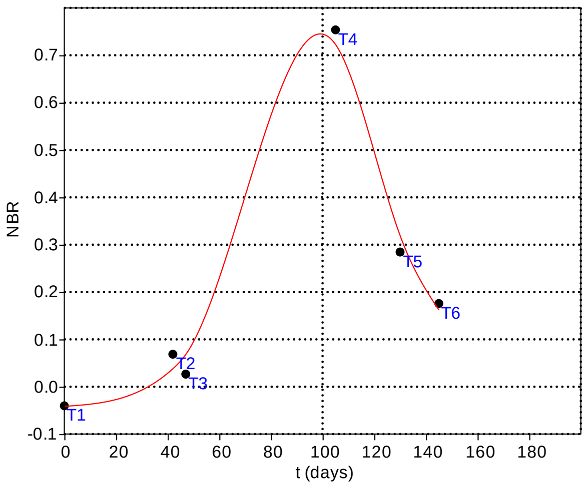

Fig. 3. NBR in relation to t (days) in sunflower culture, according to the spline model
Source: original graphic obtained from data processing.

In both the NDVI and the NBR index, a maximum was found around July 27 (T4), associated with the vegetation stage of the flowering plants.
An interdependence relationship, described by equation (4), was found between NDVI and NBR, in conditions of statistical safety (R^2 = 0.986, p=0.0015, F=112.7). The graphical distribution of NBR values in relation to NDVI is shown in Figure 4.

$$NBR = -7.573x^3 + 9.768x^2 - 1.248x - 0.04876 \quad (4)$$

where: x - NDVI values;

Regression analysis was used to estimate flower production based on the values of NDVI and NBR indices resulting from spectral information of satellite images, taken during the vegetation period of the sunflower crop.

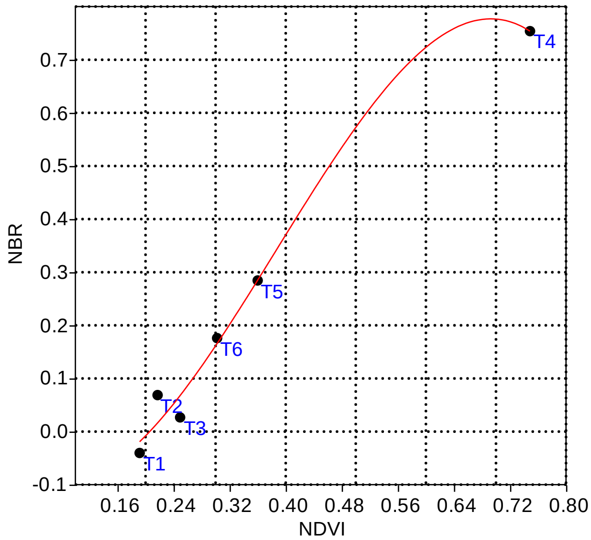

Fig. 4. Graphic distribution of NBR values according to NDVI in sunflower culture
Source: original graphic obtained from data processing.

The prediction of flower production (Y_P) based on the values of NDVI and NBR indices, was possible in statistical safety conditions (R^2=0.998, p <0.001), equation (5). The graphical distribution of the production in relation to the indices NDVI (x-axes) and NBR (y-axes) is shown in Figure 5 as a 3D model, and in Figure 6 as isoquants.

$$Y_P = ax^2 + by^2 + cx + dy + exy + f \quad (5)$$

where: Y_P - sunflower production (kg ha^{-1});
x – NDVI index; y – NBR index;
a, b, c, d, e, f – coefficients of the equation (5);
a= -94262.4890711; b= -42049.8493233;
c= 38115.8634605; d= -25389.4108121;
e= 126038.5049952; f= 0

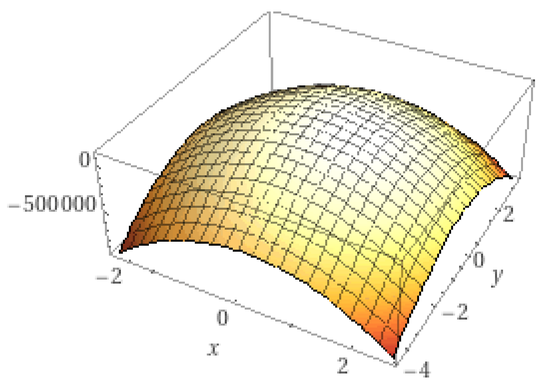

Fig. 5. 3D model distribution of Y_P in sunflower culture based on NDVI (x-axis) and NBR (y-axis) values
Source: Original graph based on data analysis.

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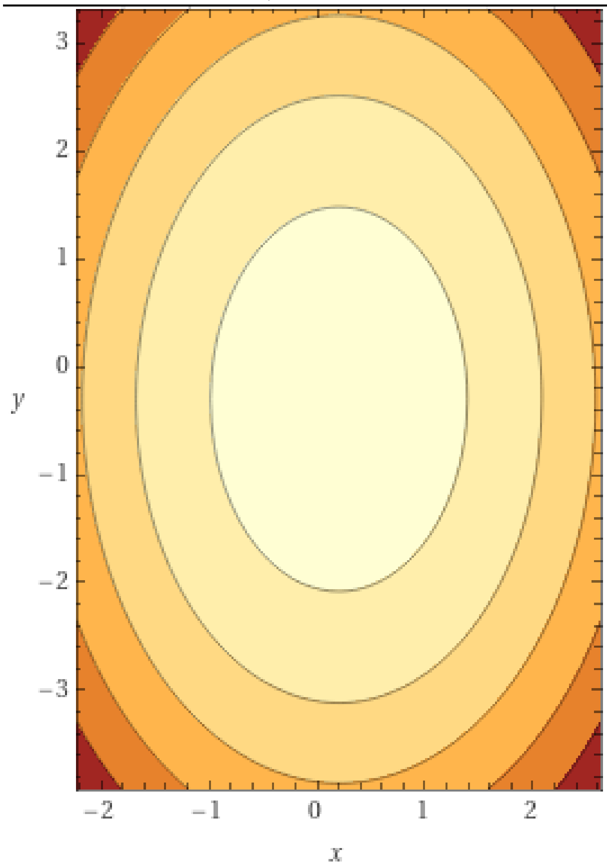

Fig. 6. Isoquants model distribution of Y_P in sunflower culture based on NDVI (x-axis) and NBR (y-axis) values
Source: Original graph based on data analysis.

Starting from equation (5), the production was calculated based on each pair of values of the NDVI and NBR indices in the 6 moments of capturing the satellite images. The predicted yields (Y_P) were compared with the actual yield obtained (Y), and the prediction error is represented graphically in Figure 7. The variation of the prediction error was found between -0.331 kg ha^{-1} in the case of T4 indices (July 28) and 42,722 kg ha^{-1} in the case of T6 indices (September 6).

The evaluation of the similarity of the stages in the case of sunflower culture, quantified through the prism of the two indices (NDVI and NBR), was made by Similarity and Distance Indices (SDI. The T4 moment was positioned on an independent position, with the highest values of the NDVI and NBR indices. It is also the T moment of the images sampling, for which the values of the NDVI and NBR indices provided the most reliable predicted production (Y_P) of sunflower crop, appreciation made based on the predictive error (Figure 7). The highest level of similarity was recorded between T2 and T3 (SDI = 0.05285) (Table 4).

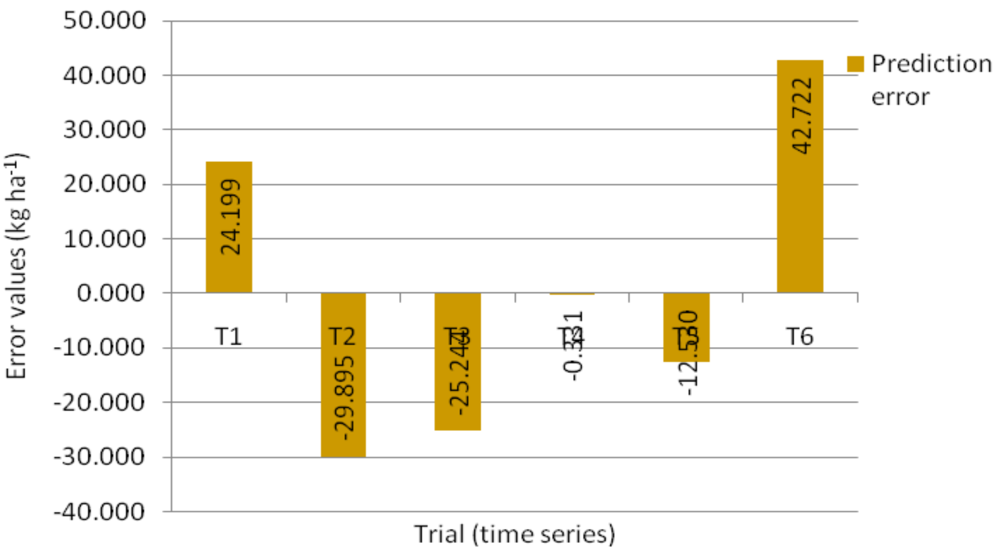

Fig. 7. Graphical representation of the prediction error of sunflower production based on NDVI and NBR indices
Source: Original graph based on data analysis

The description of sunflower vegetation stages based on Landsat 8 satellite images and calculated indices was communicated by Herbei and Sala (2015) [15] in conditions of high statistical safety. The authors of the study found the variation of the values of the indices in relation to the maintenance works and the vegetation stages (BBCH code) of the sunflower culture.

Table 4. SDI values in the case of sunflower culture studied

	T1	T2	T3	T4	T5	T6
T1		0.11189	0.08833	0.96983	0.36576	0.24274
T2	0.11189		0.05285	0.86697	0.25875	0.13676
T3	0.08833	0.05285		0.88198	0.28055	0.15829
T4	0.96983	0.86697	0.88198		0.60926	0.73022
T5	0.36576	0.25875	0.28055	0.60926		0.12304
T6	0.24274	0.13676	0.15829	0.73022	0.12304	

Source: Original data, obtained from the calculation.

Similar studies have recently been reported by Narin et al. (2021) [32], based on satellite images in Sentinel-2.
Variable levels of correlation were found in relation to the BBCH stages in which the images were taken.
Based on remote sensing, Peña-Barragán et al. (2007) [38] monitored some weeds in sunflower culture in relation to vegetation stages.
The variation of the NDVI and NBR indices considered in the present study to characterize the sunflower culture, presented maximum values around July 27, after which a descending distribution of values was registered, associated with the evolution of the culture. Minimum values were recorded in the primary stages of vegetation, when in the captured satellite images a high share was represented by the soil. Also, lower values compared to the maximum were recorded towards the end of the vegetation period, as a result of the biological maturation of the plants. The obtained results can be the basis of some models of temporal variation of the sunflower culture, in the study conditions, deviations from the normal evolution model being associated with different possible deficiencies in the culture (weeds, uneven density, diseases or pests).

CONCLUSIONS

The values of the NDVI and NBR indices resulting from the satellite images, Landsat 8, facilitated the description of the temporal variation of the sunflower culture, in the conditions of a specific culture technology, at farm level.
Spline-type models were found to be the most appropriate to describe the temporal variation of NDVI and NBR index values relative to time (t) during the vegetation period in sunflower culture under study conditions.
The production (Y_P) was predicted based on the values of the NDVI and NBR indices in high conditions of statistical safety and 3D and isoquants models of production expression were obtained.

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DEMOGRAPHIC ASPECTS IN ROMANIA POINTING OUT THE PROBLEMS OF THE RURAL POPULATION

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Abstract

The concept of sustainability or sustainable development has become, especially in recent decades, one without we cannot establish and build a paradigm that meets the necessary and viable elements for a functional society of the future. There is a rich literature on sustainability, but we aim to analyze and bring to light a holistic transdisciplinary perspective useful into learning about a certain part of social reality: quality of life in rural areas of Romania, from the perspective of sustainable development. The main goal of the research we undertake is an analysis of the aspects considered to be relevant and effective in terms of subjective and objective indicators essential into describing a very important phenomenon and social, economic, cultural, spiritual process: quality of life. We capture both the qualitative and quantitative aspects of the key concepts: quality of life, sustainable development, rural environment and we analyze them. We bring into light the concept of sustainable development and its social, economic, cultural and spiritual implications as it is mentioned in Brundtland report. The methodology is based on several complementary working tools. We mainly use, significant and recent INNS and Eurostat statistics on topic, and also integrate a series of indicators - subjective and objective - relevant to clarify the aspects brought in the research. The results of our current study reveal the way sustainable development impact demographic aspects in Romanian rural areas.

Ke y words: *sustainable development, quality of life, rural environment, marginalization, social exclusion*

INTRODUCTION

In academic and political circles around the world there is a substantial concern about sustainable development and how it can be applied with the concrete beneficial result and effects visible into society.

Why has this concept become so popular and widespread in all areas of social and scientific life? We believe that, among other things, is due to the great responsibility that the very essence of this concept bears:

Lets act today in ways that not ruin and exhaust the resources that we and the next generations will use [3]. This is one of the most important idea of the Brundtland report. It is an act of great responsibility. This make us wonder ourselves: Is it that people are now behaving irresponsibly? Unfortunately, the answer is ***yes.***

The history of at least the last four or five decades fully demonstrated it. There is no hierarchy of the things or actions that have led to, for example, global warming, but it is surely an act of moral responsibly to act in regard to find solutions, locally and globally.

In this context, the purpose of the research is to bring into the light the impact of sustainable development over the demographic aspects in Romanian rural areas and to reveal the impact over quality of life. Due to ever changing dynamics of society and its domains we are offering not final perspectives but benchmarks of improving the researches regarding the impact of sustainable development in Romanian rural areas.

MATERIALS AND METHODS

The methodology we use is based on several complementary working tools.

We mainly use, significant and recent National Institute of Statistics and Eurostat statistics on topic, and we also integrate a series of indicators - subjective and objective - relevant to clarify the aspects brought in the research.

We documented articles [1],[5], official reports [3] [9] [10][17][18], conferences [13], book reviews [8] a wide variety of bibliography from different fields of activity: agriculture, sociology, psychology, philosophy, economics, statistics, education, specialized literature in specialized magazines.

This gives substance from the perspective of the transdisciplinary approach that we announced that we use as an exhaustive working and researching method.

RESULTS AND DISCUSSIONS

There is no scale of the importance or insignificance or of the factors that contributed to the decline of the environment, soils, land, air, water, or economic crisis, the decline of human relations, alienation, social alienation that it takes place all over the world - despite huge advances, scientific discoveries and technologies. All these factors, whether they acted more or less, contributed to what we call today in generic terms as the ***global ecological crisis***.

The humankind, ***the Man***, in the way he understood and let himself led by his mind to find solutions to various problems, is the main responsible.

Therefore, the problem is both individual and collective. Of course, our goal is not to find culprits. It is an unproductive, inefficient and a time-energy consuming action.

One of our goals is to find feasible solutions, algorithms which properly applied, to lead to a sustainable coexistence. If would wanted to elucidate or expedite this situation quickly, we would answer that it is in human nature to do so. There will always be in us the reminiscences of that primitive man who runs for his own survival driven to fulfill his basic needs. Sometimes at any price, no matter how high. *The other* is always to blame. Whether this *other* is fictive or real, he remains the main motivator, who, most of the time, deepened in a sleep of selfishness and pure rationality, whispers to him or even leads him unconsciously to eliminate *thy neighbor*.

In psychology, this innate tendency of a human being to eliminate his fellow man has been called Cainism or Cain Syndrome.

In social and economic terms we define this trend by *competition for resources* (by resources we understand all kinds of resources, from material, financial to intellectual, cultural, spiritual).

On the microsocial and individual level, we can relate this competition to the desire of some human beings to accumulate as much material goods or as much praise as possible.

From a macrosocial point of view, this competition takes place at the level of nations by disputing the “assets” a nation may have.

Wherever it takes place, this competition for resources affects us all. It is felt and seen in our way of behaving. In the context of our analysis, “behaving” does not refer to and is not a superficial and transient aspect, but derives from learned models, from thought patterns, attitudinal and action patterns always repeated, which, like algorithms running in a computer, composes - in the case of humans - a life program, and even transforms and functions as an autopilot. It's what we call *mentality*.

There is nothing wrong when these algorithms run in a program that finds its operability and utility and leads to beneficial solutions and added value. The human body is in itself an extraordinarily complex program that works largely on the basis of algorithms. One is the childhood *“7 years old home education”* through which our parents implemented the rules of good behavior: for example, it is good to "say hello", "not to lie", "be good" and so forth.

This mechanism of conditioning brings us many benefits, and when we repeatedly forget to use it, in different contexts, the system as a whole is disturbed, and we can even say that it "gets infected". Then, sooner or later, depending on the environment in which it takes place and the conditions accessed, it can turn into a disease that affects and alters the body, either in part or as a whole.

Therefore, health is affected and as a consequence, this is reflected in the quality of life as a whole, whether we speak at the individual level, microsocial or at the level of a nation, macrosocial. So, one of the questions we ask is: How do we change the consumer's behavior when a virus, or an alteration takes place inside and outside the system? In specialized literature the concept of *Health of the whole common living* - developed by the prof. Constantin Popescu and prof. Alexandru Taşnadi from The Bucharest University of Economic Studies [11] - represents Value - as a criterion of appreciation of its viability materializing in the following requirements: Human health; Environmental health; Health of the organizations; Community health; Health of institutions (Fig. 1).

Fig. 1. The organic component of our common living whole
Source: [11].

We extend the perspective by adding an complementary approach which include questions about *what determines the quality of life*? What indicators can provide a better understanding of this complex and mostly subjective process of what quality life is. An answer to this question would be [4]:

a. The degree to which human being's own hopes and ambitions are realized in daily life.

b. People's perception in regard to own position in life, in the cultural and axiological context in which they live and in relation to their own goals, aspirations, standards and concerns.

c. Assessing one's own health, in relation to an ideal model.

d. Things that are considered important in people's lives.

We discuss these potential answers and others in relation to the SDG goals (Fig. 2) and SSI – (Sustainable Society Index) (Fig. 3) and try to explain to what extent and how impact over the rural quality of life in Romania in the conditions of *the age of sustainable development.*

Trying to capture what interests us in this case we will not be able to ignore what is happening at urban level or at European and global level. The comparative analysis of the different elements and indicators will give us the extent to which we can create transition solutions, or lasting solutions to the topic. In terms of sustainable development, an important desideratum refers to the *care and respect* we must look for and lead in our actions so as to manage rationally, and responsibly all the resources: human, environmental, community or society, in part and as Humanity as a whole.

The objectives established in 1987 by the Brundtland report ***"Our Common Future"*** [3] were subsequently reformulated, at the following summits. The summit held in 1992 at Rio de Janeiro (Brazil) established Agenda XXI - for sustainable development, then, in 2002, summit in Johannesburg (South Africa) added new objectives adapted to the new economic and cultural realities, so that in 2012 at the United Nation summit, New York - to be set the **2030 Agenda**, that added new objectives to the existing ones organized in two categories: Human and NonHuman Resources.

The 2030 Agenda includes 17 main objectives organized on two key coordinates [14]:

8 Human Resources

"No poverty 2. Zero Hunger 3. Good health and wellbeing 4. Quality education 5. Gender equality 6. Clean water and sanitation 7. Affordable and clean energy 8. Decent work and economic growth.

9 NonHuman Resources

9. Industry, Inovation and Infrastructure 10. Reduced Inequalities 11. Sustainable Cities and communities 12. Responsable consumption and production 13. Climate action 14. Life below water 15. Life on land 16. Peace, Justice and strong institutions. 17. Partnerships for the goals".

Fig. 2. Sustainable Development Goals (SDG)
Source: Wikimedia commons images [16].

In the context of globalization and European integration, an important desideratum - responsible and rational management of resources - is strongly reflected in the concerns of politicians, officials and academics. **Agenda 2030** - includes both the major problems facing humanity and recommendations on how these problems can be addressed in relation to certain indicators.

SSI Structure

Dimension	Category	Indicator
Human Wellbeing (HUW)	Basic Needs	Sufficient Food
		Sufficient Drinking Water
		Safe Sanitation
	Personal Development & Health	Education
		Healthy Life
		Gender Equality
	Well-balanced Society	Income Distribution
		Population Growth
		Good Governance
Environmental Wellbeing (ENW)	Natural Resources	Biodiversity
		Renewable Water Resources
		Consumption
	Climate & Energy	Energy Use
		Energy Savings
		Greenhouse Gases
		Renewable Energy
Economic Wellbeing (ECW)	Transition	Organic Farming
		Genuine Savings
	Economy	GDP
		Employment
		Public Debt

Fig. 3. Sustainable Society Index **SSI**
Source: [15].

According to **Sustainable Society Index** (SSI) [15], a sustainable society can be analyzed through the following structure: 3 main dimensions of well-being: **a)** Social dimension: Human well-being **b)** Ecological dimension: Environmental wellbeing and **c)** an Economic dimension: Economic well-being, seven categories of areas of action and 21 indicators (to which have been added 3 more in a new category- Healthy environment).

We undertake the analysis around the key concepts: sustainable development, rural environment, quality of life. The issue of sustainable development is of great interest As explained in the Brundtland report the term sustainable development define a process that involves self-sustaining development over time, being essentially a long-term development. Sustainable development is also a process that perpetuates itself and thus becomes sustainable through the equitable distribution of resources - health, education, culture, gender equality, accountability and participation in political life - and through good and responsible administration and a lucrative management system, both in the current generation and especially in future generations. All these elements emphasize once again that the vision of sustainable development must be a long-term one.

The concept of sustainable development is closely linked and interdependent with the environment. We cannot address or talk of sustainable development in the presence of a development that neglects and overlooks to ensure the optimal conditions for the protection of the environment.

The quality of the environment depends on the level of development of the society, the communities, but also on the degree of their resilience. “Sustainable development is inseparable from the quality of life and is conditioned by the harmonization of the three requirements: economic prosperity, which is based on income obtained from productive activities in order to meet people's needs; the stability of social and cultural systems, which ensure the labor force necessary for the economic, social and cultural field; the stability of natural systems, which are the basis of life and have the role of procuring natural resources and goods” [12].

In Romania, the implementation of macro and micro indicators of sustainable development described in the **2030 Agenda** is a real concern in a political, economic, social context and an issue that involves all dimensions of society's development. Going through the stages of achieving the desideratum is relatively difficult. Since the last decades of the last century, the dynamics of macro and microsocial relations have changed due to political and economic infrastructure. Romania's accession and acceptance in 2007 in the European Union brought with it a new energy that generated fundamental, structural but also unpredictable changes, in terms of property structure, money allocation, migration from village to city and political decisions.

The difficulties of implementing the economic desideratum required by the EU, as well as those of the 2030 Agenda for Sustainable Development, resulted mainly from the manifestation of the economic consumption model specific to the Romanian society as well as from a pronounced lack of direction and political and economic consistency, that led to a state of confusion and general anomy in all areas of activity.

True sustainable development presupposes first of all a qualitative leap in terms of the essential perception of the concept of development itself and the promotion of development as an absolute and unconditional goal, by and for all the nations of the world. How? By assuming a culture of sustainable development, by practicing an optimistic and inclusive mentality at all levels.

The segment subject of our research, namely the quality of life in rural areas from the perspective of sustainable development, is rich in data so we made a selection and use those we considered to be more representative so that, at the end of our research to gain a new perspective, clearer on the analyzed realities, which allows us to advance solutions also recommendations for other studies and perspectives.

The first item on the **2030 Agenda** is about ending chronic poverty. A society without poverty presupposes unitary economic development and an equitable distribution of resources. This balance can be achieved taking into account a number of factors, both objective, economic, material, and subjective, socio-psychological.

According to World Bank statistics: "Romania has one of the highest poverty rates in the European Union. The share of Romanians at risk of poverty after social transfers increased from 22.9% in 2012 to 25.4% in 2015. However, the share of the population at risk of poverty and social exclusion decreased from 43.2% in 2012 at 37.4% in 2015" [18].

According to local statistics (2011 Population Census) rural areas in Romania are organized into 2.861 communes (administrative units) including 12.373 villages containing 46.547 census sectors in villages, of which 5.3 percent are very small (less than 50 inhabitants), while about 1 percent are large (with 500 inhabitants or more) [10].

The number of census sectors per village varies considerably depending on the size of the population, from at least one sector per village to a maximum of 41 sectors in two villages.

Closely related to poverty and as a consequence of this it is *marginalization and social exclusion*, then practically all the other aspects described as human objectives of the 2030 Agenda: ending hunger, health and well-being, quality education, gender equality, clean water and health services, clean and available energy for all, decent jobs and growth.

Usually, the phenomenon of marginalization and social exclusion is associated either with the Roma population communities or with the small number of inhabitants in a community. However, these are not the most significant aspects.

Specialized studies show that Roma communities predominate in villages near cities (0.5 to 10 kilometers) while non-Roma communities predominate in isolated villages, ie more than 32 kilometers away from the nearest city.

In fact, less than 10% of Roma communities live in remote villages.

In Romania, a village is considered close to the city when the distance from it is up to 10 kilometers, between 10 and 32 kilometers is a moderate distance, and a commune, a village located over 32 kilometers from the city is considered remote.

In rural areas, the location of the village in the commune, the level of infrastructure development, easy access to everything that means public services, public transport, local institutions, church, school, hospital, police, etc. are significant elements that generally signal the degree of marginalization and of spatial exclusion.

The lack of infrastructure development is directly observable by the lack of modern roads, usually these being land, the lack of local water network, communications.

Depending on these factors, the territorial administrative units (TAUs) are divided into three groups: “developed” communes, “medium-developed” communes and “poor” communes.

According to statistics made by the World Bank, using the estimated relative poverty rates, in 2019, in Romania there were 992 marginalized rural communities (35% of all communes in the country). In 535 of these communes, with a total number of 427,046 inhabitants, the poverty level is above average and severe.

At the country level, 38% of the rural population is in poverty, the most exposed categories being children, the elderly, people with disabilities and the Roma population. The poorest areas in Romania are the northeast 33% and the southeast 30%.

On a larger scale, comparatively, at the level of the European Union, according to Eurostat, in 2016, 23.5% of the EU population, ie 118.0 million people lived in households at risk of poverty and social exclusion, due to lack of material resources or low-level, low-wage work paid, by people of working age who have worked only 20% of their potential in the last 12 months [6].

Material deprivation refers to that aspect of poverty in which the person cannot cover unexpected expenses or cannot afford to have a meat-based meal, or certain goods such as a telephone or car.

In Romania, mortality rates are much higher compared to those of most EU Member States, with large gaps in the average life expectancy of males and females, respectively, in Romania and other European countries. Mortality rates are substantially higher in rural areas compared to urban areas.

Between 2005-2018 infant mortality registered a continuous decreasing trend, being higher in certain periods (2013), the level of the rate is still very high, - 6.4 deaths under 1 year of age per 1,000 live births. In 2018, the issue remains a priority in public health policies. Between 2008-2019, the natural growth was permanently negative. (Table 1).

Table 1. Resident population, by age/gender at January 1st, 2008 and 2019*

Age Year Total	Total 2008/2019 100	Male 2008/2019 100	Female 2008/2019 100
0-4	5.1/5.1	5.4/5.3	4.9/4.8
5-9	5.2/5.1	5.5/5.4	5.0 /4.9
10-14	6.0/5.5	6.3/5.7	5.7/5.2
15-19	6.3/5.4	6.6/5.6	6,0/6.1
20-24	7.2/5.2	7.6/5.4	6.8/5.0
25-29	7.0/5.8	7.3/6.1	6.7/5.4
30-34	8.0/7.0	8.3/7.4	7.6/6.6
35-39	7.0/7.1	7.3/7.4	6.8/6.7
40-44	7.8/8.0	8.1/8.4	7.4/7.7
45-49	6.1/7.7	6.2/8.2	5.9/7.4
50-54	6.7/7.0	6.8/7.3	6.7/6.7
55-59	6.4/5.7	6.3/5.8	6.5 /5.7
60-64	5.8/6.8	5.5/6.6	6.1/7.2
65-69	4.6/6.2	4.2/5.6	5.1/6.8
70-74	4.4/4.3	3.7/3.7	5.0/4.8
75-79	3.4/3.4	2.7/2.7	4.0/4.0
80-84	1.9/2.7	1.5/2.0	2.4/2.4
85 +	1.1/2.0	0.7/1.4	1.4/2.6

Source: NIS, 2021 [10].
Note: No. data available for 2020.

Also, the phenomenon of population aging is acute. The phenomena that contributed to the increase of the aging rate being mainly: the decrease of the birth rate and the increase of the international migration (Table 2).

In Romania, as a result of the low birth rate and the emigration of the young population, the share of age groups has decreased to 30 years. Other affected groups are 20-24 years (2.8 percentage points), respectively 25-29 years (1.7 percentage points).

According to NIS statistics, [9] on January 1, 2019, the average age of the female and male population in Romania increased, compared to the same date of previous years. The average age of the female population is 3.2 years older than the average age of the male population.

The rural population is older, with an average age of 42.2 years, 0.2 years older than the urban population (42.0 years). Reflecting even only on these analyzed aspects: number of ATUs, marginalization, birth rate, mortality, natural increase - and we can better understand some of the causes that determine the level of poverty in Romania to be very high. In terms of sustainable development, the aging trend of the population has a profound impact that is reflected in all areas of activity: economic, social, education, cultural, as well as on all future generations.

Table 2. **Demographic aging index** (DAI) and **Demographic dependency ratio** (DDR), at January 1st 2010-2019*

Year	**2010**	**2011**	**2012**	**2013**	**2014**
DAI	102.1	101.8	101.8	103.8	106.3
DDR	46.1	47.0	47.0	47.0	47.2
Year	**2015**	**2016**	**2017**	**2018**	**2019**
DAI	109.3	112.1	114.4	116.3	118.8
DDR	48.2	49.0	50.0	51.1	51.9

Source: NIS, 2021 [9].
Notes: No data available for 2020.
Indicators are calculated at 100 adults/100 children

Compared to other UE states, in Romania, the risk of poverty and social exclusion due to poverty, in 2019 was 31.2 lower than the data reported in previous years: 41.9 in 2013/ 40.3 in 2014 / 37.4 in 2015 / 38.8 in 2016 / 35.7 in 2017 / 32.5 in 2018. Eurostat statistics show that in 2020, the level decreased to 30.4. (Fig.4).

Romania has, along with Bulgaria, one of the highest rates of risk of poverty and social exclusion in the European Union.

From the perspective of sustainable development, in the analysis of the social inclusion ratio, three correlative dimensions are usually taken into account: material deprivation from the economic point of view of the household, material deprivation from the point of view of owning durable goods and material deprivation with reference to the quality of living conditions and which overall influence the quality of life.

Globally, one of three Romanians is at risk of poverty.

"In general, the groups subject to social exclusion are those of Roma citizens. Due to the COVID19 pandemics, the situation worsened for the vulnerable and disadvantaged categories, so that 35.8% of the 3.7 million children in Romania are at even *higher risk of poverty and social exclusion.* 400,000 children do not go to school, and over 50,000 children are separated from their families, largely due to poverty, the departure of their parents to other countries for a better life, but also violence and family abandonment" (Eurostat) [7].

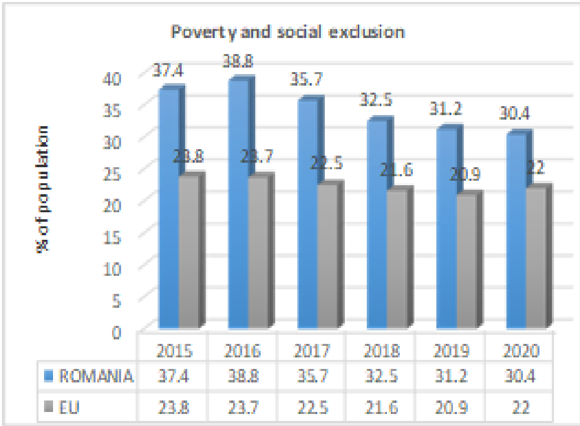

Fig. 4. People at risk of poverty and social exclusion
Source: [17].

The 2011 census highlights the fact that, from the perspective of demographic developments, and by reference to the two main indicators: the resident population and the population by domicile, in 2019, Romania's population - by domicile - was 22.17 million people, decreasing compared to 2018 with 43,000 people.

According to the same provisional data provided by INS, in 2019, the resident population was 19.4 million inhabitants, down by 1.6 million people. The female population is larger (51.2%) than the male. At the regional level, population density is more concentrated in important economic centers, Bucharest 9.6% and Iasi 4.3%, at the opposite pole being Sălaj, Tulcea and Covasna with 1.1% and 1%.

The level of poverty is closely linked to the level of income of citizens on the one hand, but also to the lack of strategies at country level to reduce social disparities and promote social inclusion, equity and quality in education through spending on education, by increasing GDP and the implementation of social programs that supports the gradual improvement of education in the rural areas.

In relation to quality of life, **HDI** - the human development index includes indicators: **ALE** average life expectancy, **EI** Education index (expressed by school employment rate) and **GDP**/capita - Gross Domestic Product per capita [2].

$$\textbf{HDI} = \frac{\textbf{ALE + EI + GDP/capita}}{\textbf{3}}$$

Although citizens incomes increased in 2018, due to the increase in pensions and salaries, this did not contribute to the reduction of inequalities, the share of the low-income segment increased, being among the lowest in the European Union.

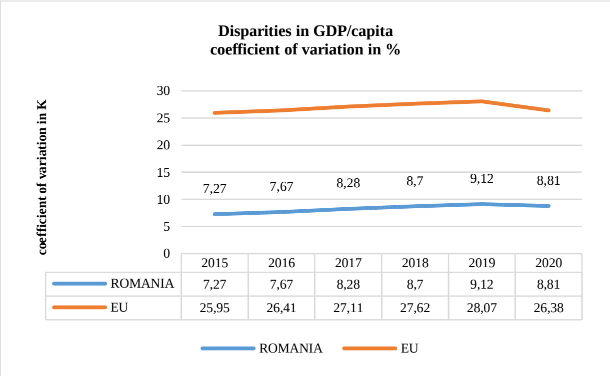

Fig. 5. Disparities in GDP per capita between Romania and EU, 2015-2020
Source: [17].

The gap between GDP/capita in Romania and the EU is obviously high (Fig. 5).
Also, the difference between urban and rural are significant, both at national level and compared to the European average (Fig. 6).

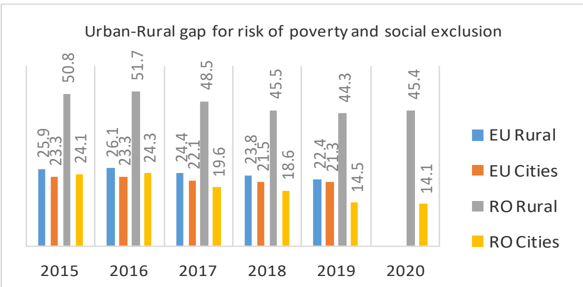

Fig. 6. Urban-rural gap for risk of poverty and social exclusion.
Source: [18].

Surprisingly, despite the discrepancies due to the level of poverty, between the countries of the European Union with poor living conditions (damp walls, lack of foundation, windows, etc.), in 2020 Romania is next to countries such as Austria, with a rate of 9.4% of the total population, Cyprus being the first on the list, severely affected by 31.3% and Finland, the least affected, being the last with 4.1%.

This shows us to a large extent the importance that Romanian citizens attach to the creation of a certain relatively high climate of life, and a lifestyle from which to foresee a certain level of well-being, often in contrast with the level of income or social status

This has a direct and negative impact on the efforts to implement the vision specific to sustainable development.

In Fig. 7 it is shown the relative median at risk of poverty gap between Romania and the EU in the period 2015-2020.

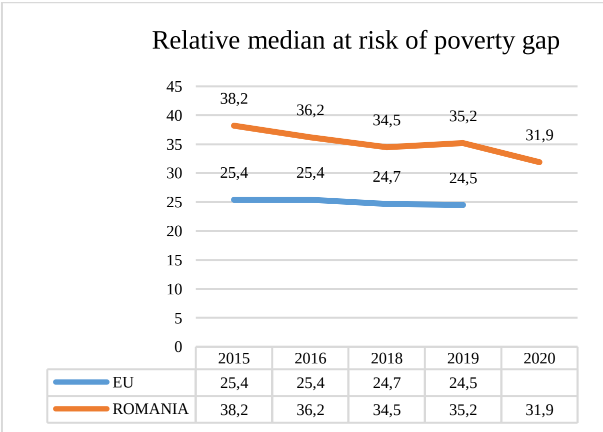

Fig. 7. Relative median at risk of poverty gap in Romania compared to the EU (No available data for EU 2020)
Source: [18].

CONCLUSIONS

The lack of social policies to facilitate solidarity and cohesion of communities are serious barriers that make it difficult to reduce social inequalities, end poverty, access to quality education, therefore a decent standard of living and living standards, which contribute to increasing the quality of life as a whole, both in urban and rural areas.

On the Eurostat map of the 17 indicators of sustainable development, certain dimensions are better positioned, however, the gaps regarding the situation in Romania determine an overall picture very diverse.

Each of the 17 main objective and subsequent objectives offer an overall portrait to a better understanding of the impact of sustainable development in Romania. In regard to this diverse and really unique picture of Romanian realities we pose a related and legitimate question: Why - after more than a decade of implementation in Romania most of the objectives are so low on the Eurostat map? Also, what are the capabilities we need to strengthen in order to obtain more visible and sustainable results that ultimately would led to a better quality of life - both in urban and rural areas, locally and globally?

Fig. 8. SGD Scores Romania overall
Source**: [7].**

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THE EFFECT OF GLOBALIZATION ON ROMANIAN TOURISM, DURING THE COVID-19 CRISIS

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Abstract

Tourism, one of the branches that recorded among the largest losses during the Covid-19 pandemic, both globally and nationally, is the subject of the case study. These losses were due both to the travel restrictions imposed by each state, but also to the reluctance of tourists to travel, especially in 2020. Therefore, the number of tourists has decreased considerably, both in terms of resident tourists and tourists. non-residents. That is why in this paper we set out to analyze the ways in which the development of the Covid-19 pandemic influenced the tourist traffic, taking into account the non-resident tourists who arrived in Romania. We found that the incoming activity of tourists was well below the outgoing activity, which negatively influenced both the tourist entities and the complementary sectors, which in turn are related to the entire national economy. The research methodology consisted in collecting the existing data on the website of the National Institute of Statistics, as well as in other specialized databases, their processing, analysis and formulation of conclusions. Different research methods were used: analysis, deduction, graphical method, comparative method, as well as a series of indicators with a fixed base through which we highlighted the change in time of tourist traffic, as well as their growth rate. Based on the analyzed data, conclusions were formulated that allowed us to characterize the existing situation on the Romanian market in the period 2018-2020.

Key words**:** *globalization, non-resident tourists, tourist traffic, Covid-19*

INTRODUCTION

Tourism is the economic activity that operates globally and that has allowed people to travel, people who come from different all social classes whose income has increased and allowed them to do so. Therefore, the number of tourist destinations has increased, and tourism has become the engine of socio-economic progress, due to the fact that it has created new jobs, but has also contributed to the development of other related sectors [3].

Globalization is a term to which several meanings can be attributed and which involves the development of existing financial markets globally, the development of multinationals, the movement of labor, the circulation of information, increased mobility, etc. [5, 15].

Under these conditions, globalization also involves tourism, as an important part of contemporary socio-economic activity that has led to opportunities as a result of the contribution that both technology and communication and transport have had on this sector of activity [6].

Due to the speed of information dissemination, tourism has led both to increase the efficiency of services provided, but also to increase the quality of services provided which has led to the development of this sector of activity [7].

However, globalization also has its downside, which has affected especially the less developed countries, due to the misallocation of resources, due to the growing domination over national economies, the penetration of market values in areas to which they do not traditionally belong [8].

At present, tourists are dependent on communication, on the fact that they have at their disposal a modern information technology, that they can choose the services they want, that they can plan their holidays, which makes them more individualistic, more pretentious, more exclusive. At the same time it benefits from a greater flexibility to travel.
The Covid - 19 crisis, however, brought changes. According to the World Tourism Organization worldwide, the number of tourist arrivals in 2020 was only 27% compared to the previous year [2].

MATERIALS AND METHODS

The scientific researches were performed based on data from the National Institute of Statistics, the Ministry of Tourism, and other sources of economic data. The data used as sources of primary economic information belonged to the years 2018, 2019 and 2020, quarters III and IV, given the fact that for the first and second quarters of 2020 the publication of data was postponed due to the Covid-19 crisis. For the year 2021, at the date of writing the article, there was information regarding the first semester, so I also referred to some of this information. The research methods used in the study were: Analysis, Deduction, Graphical method, Comparative method.
In order to follow the variations registered in the analyzed period, we used the chronological series, which are a way of following the evolution of economic phenomena and which can be highlighted by processing the available data according to time and which can be formed by different categories of indicators. The calculation methodology was based on an analytical function of shape time:

$y_i = f(t_i)$ where: [1]
y_i – the values of the variable
t_i – numerical values of the time variable

Because the relative quantities refer to the level of a period that has variations compared to the base period or to the recording of changes in the values of the analyzed phenomenon in the studied period compared to the reporting period, in this paper we used the dynamics of indices aimed at presenting changing the time of tourist traffic. The indicator was calculated as a report, taking into account the values recorded in the analyzed period (2018-2020) and the values recorded in the base period (2018), as follows:

$$I_{i/0} = \frac{yi}{y0} \text{ x } 100,$$

where:
y_0, y_i – the values of the variable in the analyzed period
$I_{i/0}$ – growth rate
The calculation of the growth indices per chain was made as a ratio between the values determined at the level of the study period (2018-2020) and the level of the values registered in the basic period (2018), as follows:

$$I_{i/i-1} = \frac{yi}{yi-1} \text{ x } 100,$$

where:
$I_{i/i-1}$ – growth rate
In order to highlight the growth rate of the indicators referring to the tourist circulation, we used the index with a fixed base, according to the relation:

$$R_{i/i-1} = \frac{yi-y0}{y0} \text{ x } 100,$$

where:
$R_{i/i-1}$ – growth rate
y_0, y_i – the values of the variable in the analyzed period.

RESULTS AND DISCUSSIONS

The years 2020 and 2021 were atypical years in terms of economic and social activity given the Covid-19 pandemic, therefore tourism was no exception. The effects of the Coronavirus pandemic on tourism in Romania are reflected in the statistical data.
The data analyzed in the paper follow the tourist circulation of non-resident tourists in Romania. For the first 2 quarters of 2020, the

National Institute of Statistics postponed the publication of data, so we chose that in this paper, to analyze the situation of tourist traffic of non-residents for the last two quarters of 2018, 2019 and 2020. We also did a comparison between the tourist movement of non-residents in the first quarter of 2018 and 2019, before the Covid-19 pandemic, and the first quarter of 2021. In this way we tried to understand how the Covid crisis influenced travel decisions and how tourists to travel.

From the analysis of data for the period 2018-2020 we found that in the last two quarters of the year, the number of foreign tourists, both those who travelled for business and car, and those who travelled individually, on vacation, visiting relatives, etc. the reason decreased significantly, being represented by the pandemic restrictions imposed both by Romania and by the other countries.

Thus, if in terms of business travel, the decrease in the number of tourists was only 4% in the third quarter and 1.5% in the fourth quarter of 2019, the same cannot be said about 2020 when it reached a decrease of 89.88% both in the third trimester and in the fourth trimester (Fig. 1).

It is thus found that the highest number of tourists was registered in 2018, their number being 938.3 thousand. In 2019, their number was 900.3 thousand tourists, but the decrease was not significant compared to the previous year. The dramatic decrease took place in 2020. This percentage decrease was 90%. The same is true for the fourth quarter. What is noteworthy is the fact that in the fourth quarter the tourist traffic is lower by about 40% compared to the third quarter, for the entire analyzed period.

The rate of dynamics of the number of tourists in 2020 compared to 2018 was -5%, which also meant a decrease in tourism spending. We find that in 2020 they were 190.4 million lei (third quarter), respectively 139.2 million lei (fourth quarter).

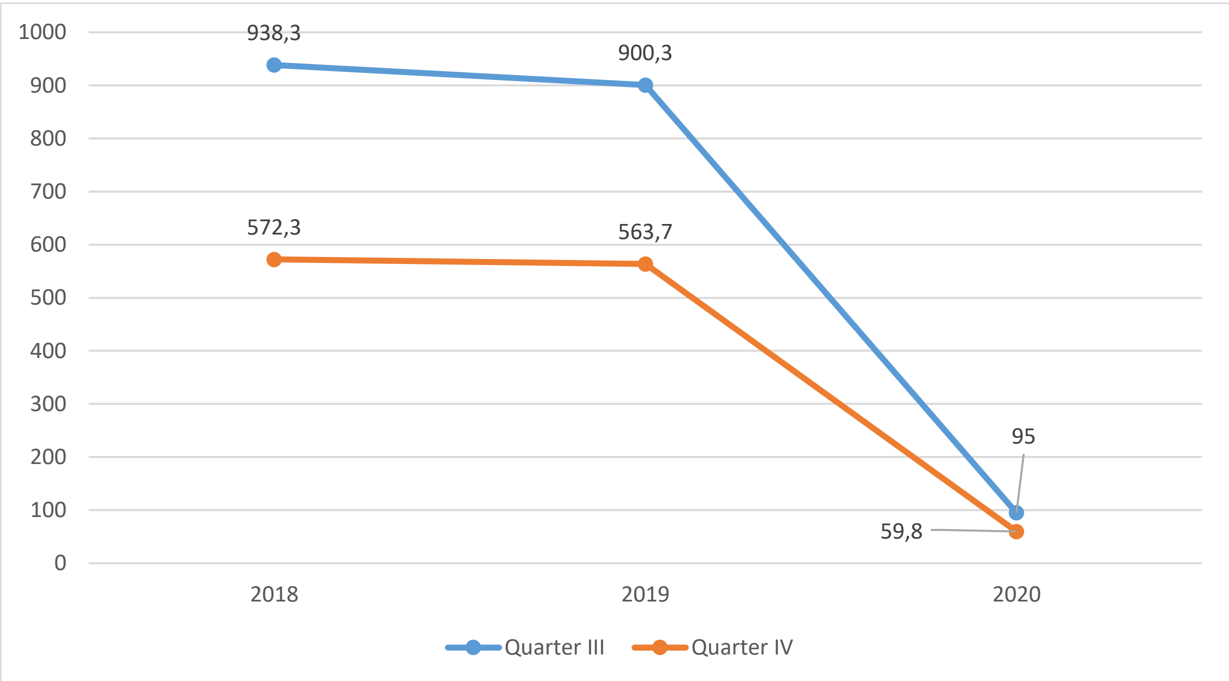

Fig. 1. Situation of the number of tourists in the period 2018 - 2020 (thousands of tourists)
Source: own processing [10-14].

Regarding the pace of tourism spending dynamics in 2020, in the third quarter it was -91%, while in the fourth quarter it was -40.2%. The difference is due to the fact that the third quarter is during the holidays, the period in which the share of travel is the highest during the year in terms of individual travel.

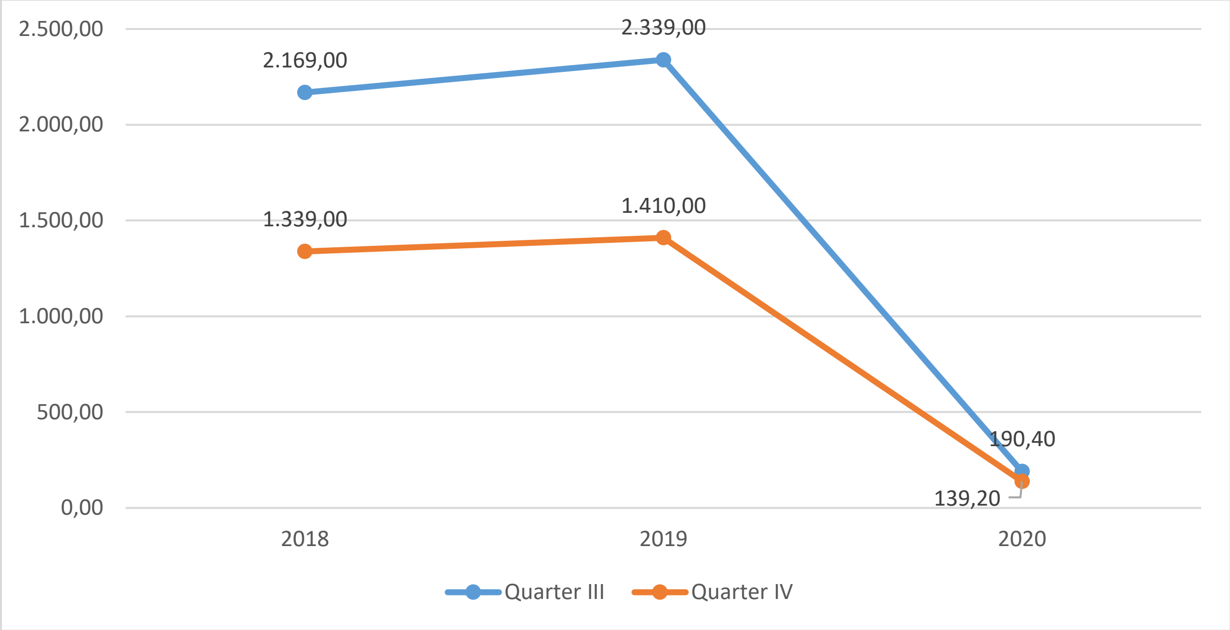

Fig. 2. Situation of the total tourist expenses in the period 2018-2020 (Lei Million)
Source: own processing [10-14].

Analyzing the structure of expenditures, in the case of business tourism we find that throughout the analyzed period the largest share was held by accommodation expenditures, which represented between 54.2% (2020) and 48.4% of total expenditures (Fig. 3, 4 and 5).

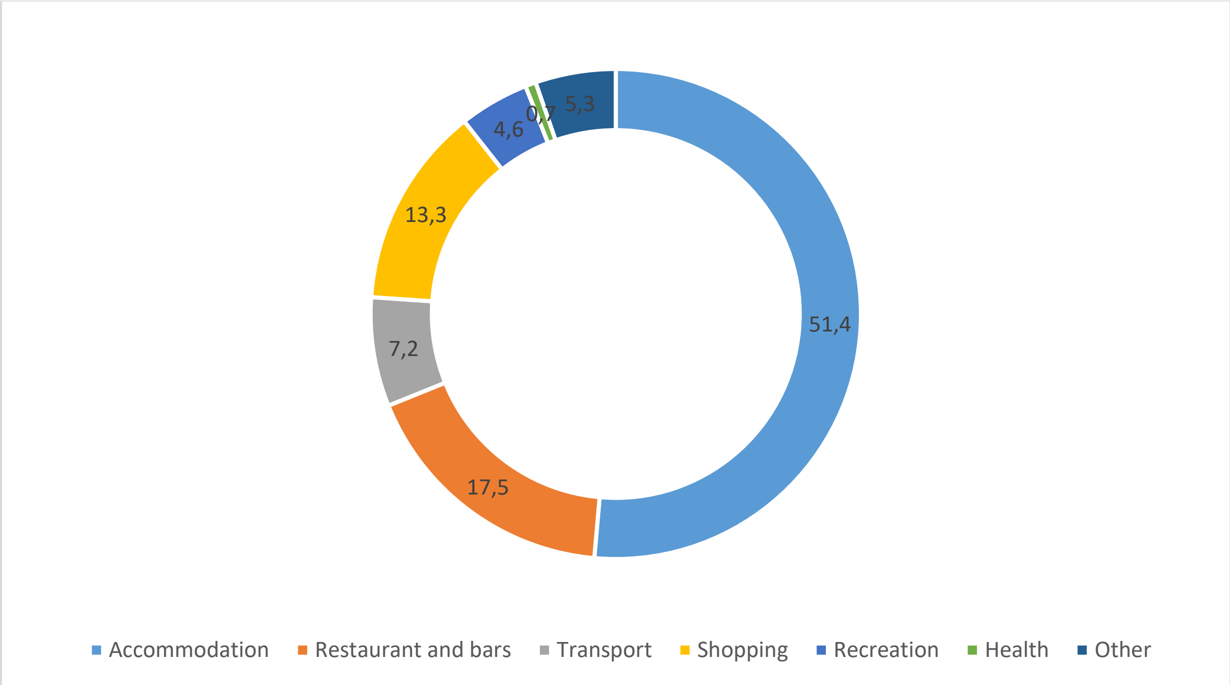

Fig. 3. The structure of business tourism expenditures, from the third quarter, in 2018
Source: own processing [14].

Restoration expenses had in the third quarter of the analyzed period weights between 19.1% and 17.5%, and in the fourth quarter they had weights between 16.3% and 17.4%.

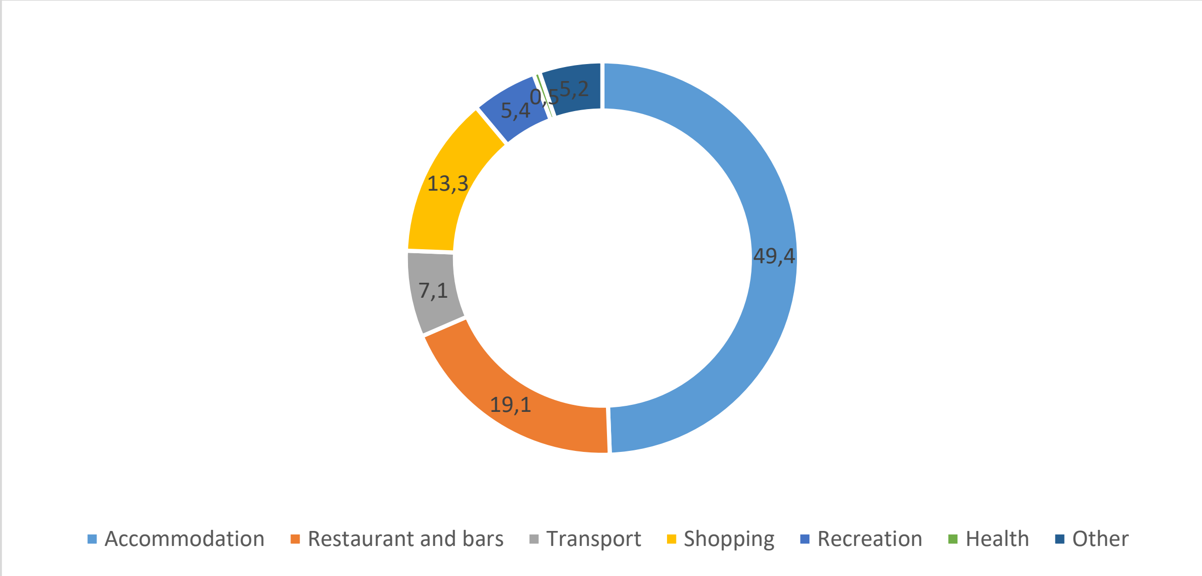

Fig. 4. The structure of business tourism expenditures, from the third quarter, in 2019
Source: own processing [12, 13].

Expenses for various purchases made during the stay occupied the 3rd place of the total expenses, followed by transport expenses, other expenses and health expenses. The total value of these expenses and implicitly the value of the revenues resulting from the provision of these services is an important one for the Romanian tourism.

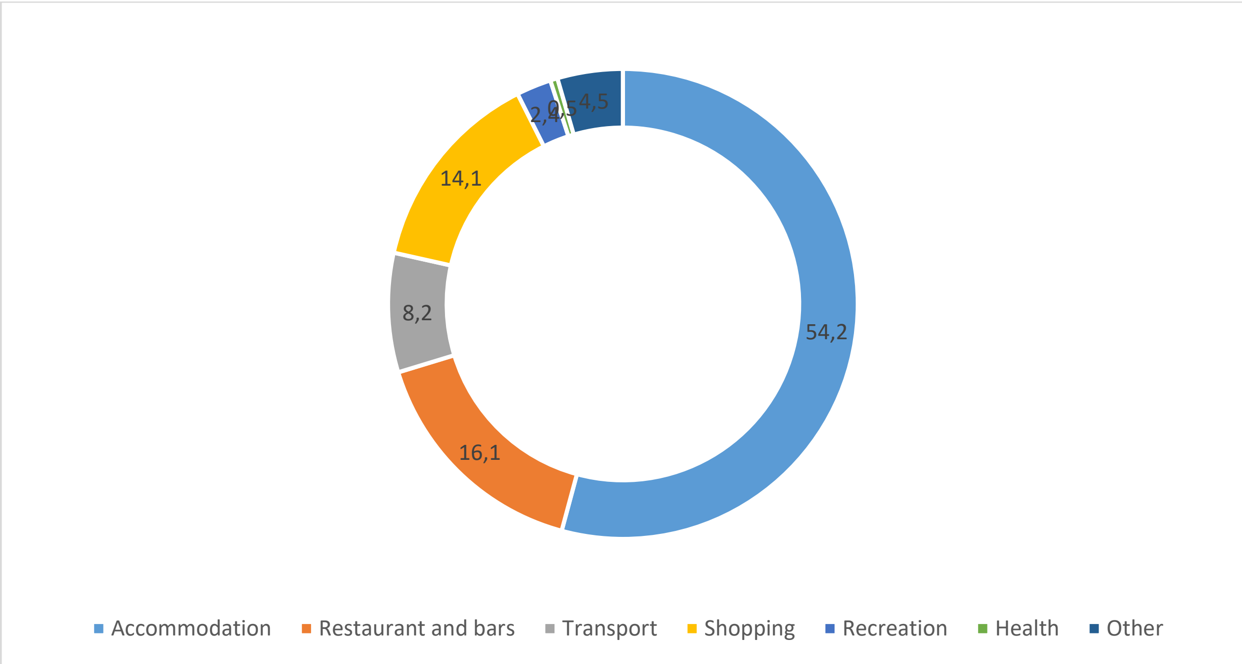

Fig. 5. The structure of business tourism expenditures, from the third quarter, in 2020
Source: own processing [11].

Analyzing the structure of business tourism expenditures for the fourth quarter of 2018-2020, it is found that throughout this period accommodation expenditures accounted for more than half of the total. The highest share was recorded in 2020, when they were almost 53% (Fig. 6).

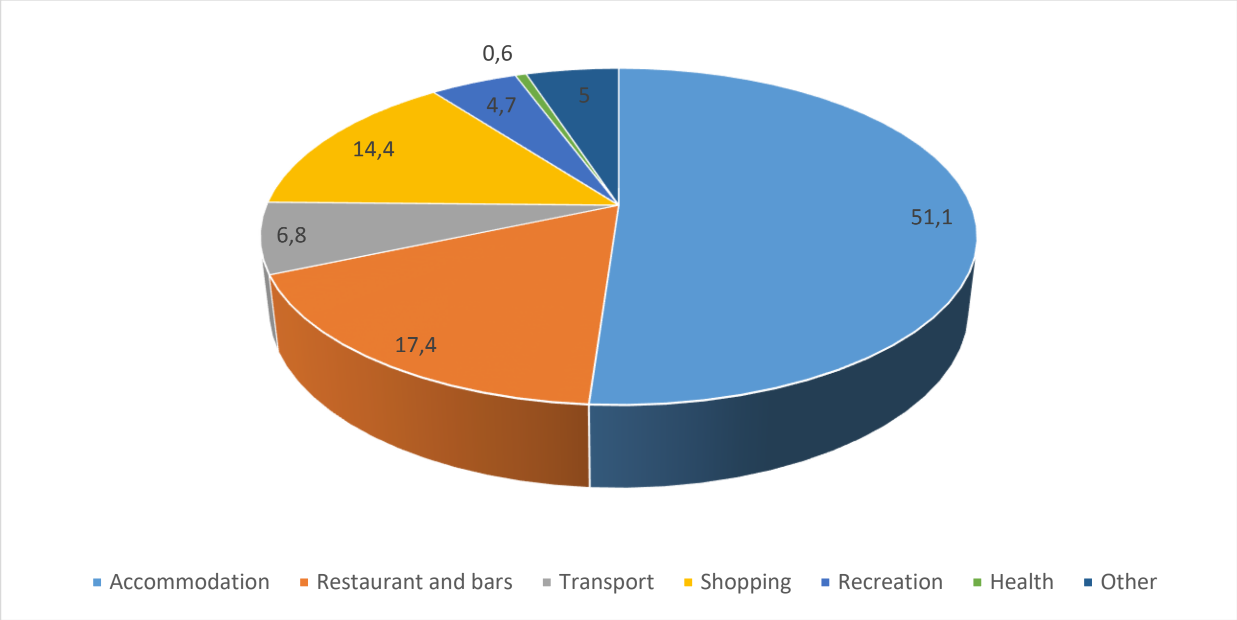

Fig. 6. The structure of business tourism expenditures, from the fourth quarter, in 2018
Source: own processing [14].

Also, the restoration expenses had high weights, between 17.4% in 2018 and 2019 and 16.3% in 2020 (Fig. 6, 7 and 8). Foreign tourists who came to Romania for business spent amounts that represented between 14% (2019) and 16.5% in 2020 with shopping, while for health they spent amounts that represented less than 1% of total expenditures.

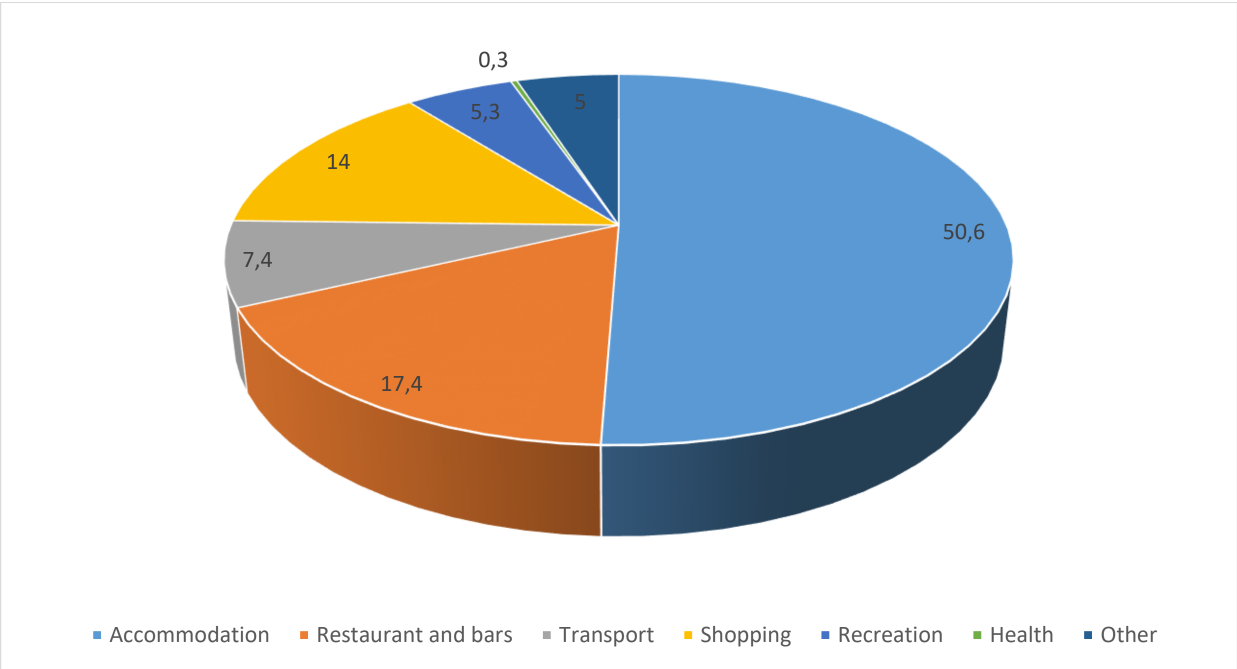

Fig. 7. The structure of business tourism expenditures, from the fourth quarter, in 2019
Source: own processing [11, 13].

The amounts spent for recreation had shares of 4.7% in 2018, 5.3% in 2019 and 2.5% in 2020, while transport expenses had shares of 6.8% in 2018, 7.4% in 2019 and 6.7% in 2020.

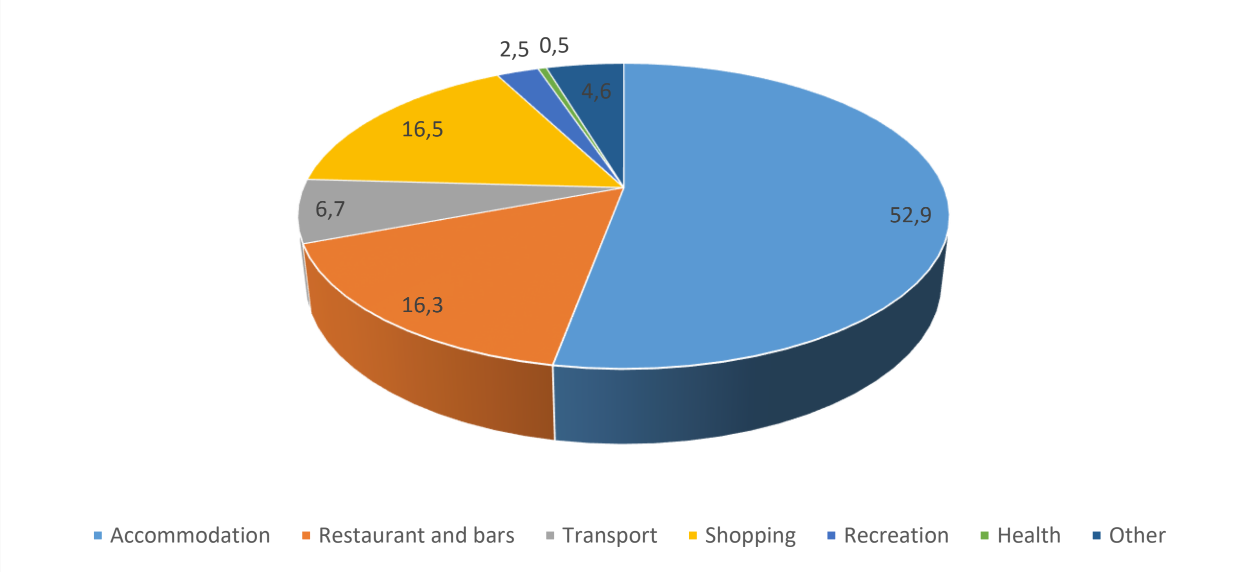

Fig. 8. The structure of business tourism expenditures, from the fourth quarter, in 2020
Source: own processing [10, 11].

Regarding the expenses that were made by tourists for individual trips, during the analyzed period their share decreased from one year to another for each of the categories already presented. Unlike business tourism, the share of accommodation expenses was lower being below 50%. In 2019, they were for example 47%. And the restoration expenses were lower, representing between 15.3% in 2020 and 18.9% in 2018.

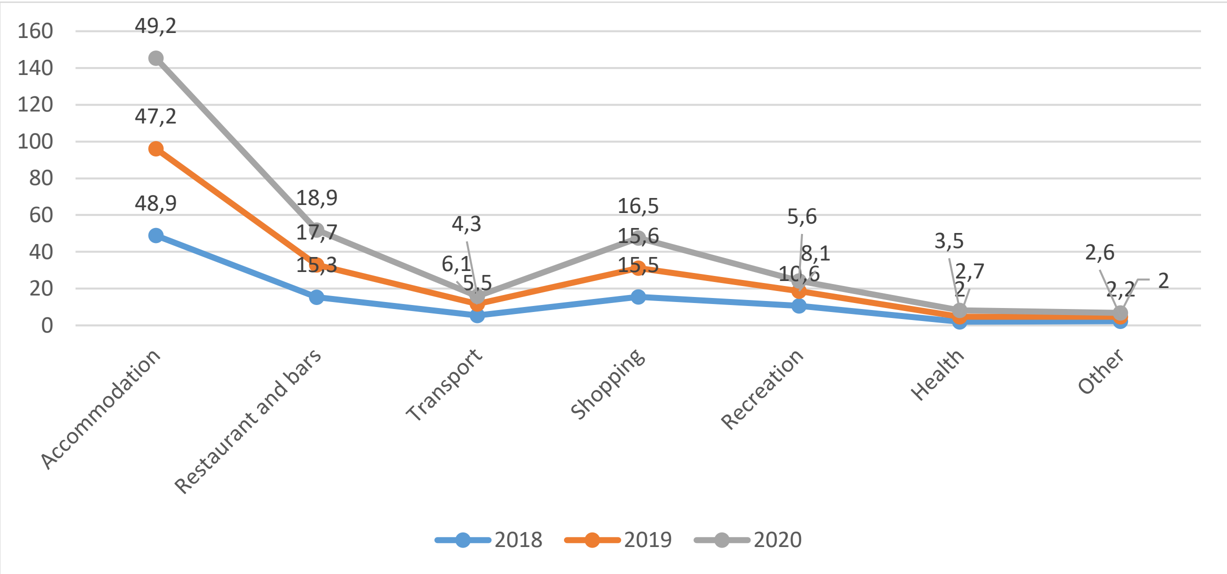

Fig. 9. Situation of individual tourism expenditures, in the third quarter, in the period 2018-2020 (%)
Source: own processing [10-14].

Being about individual tourism, it is natural that the recreation expenses are higher than in the case of business tourism. Thus, this category of expenses had weights between 5.6% and 10.6%. Another higher category of expenditures is represented by health expenditures, which in the third quarter were higher than in the fourth quarter.

Therefore, we find that tourists who came on vacation to Romania spent money to solve health problems.

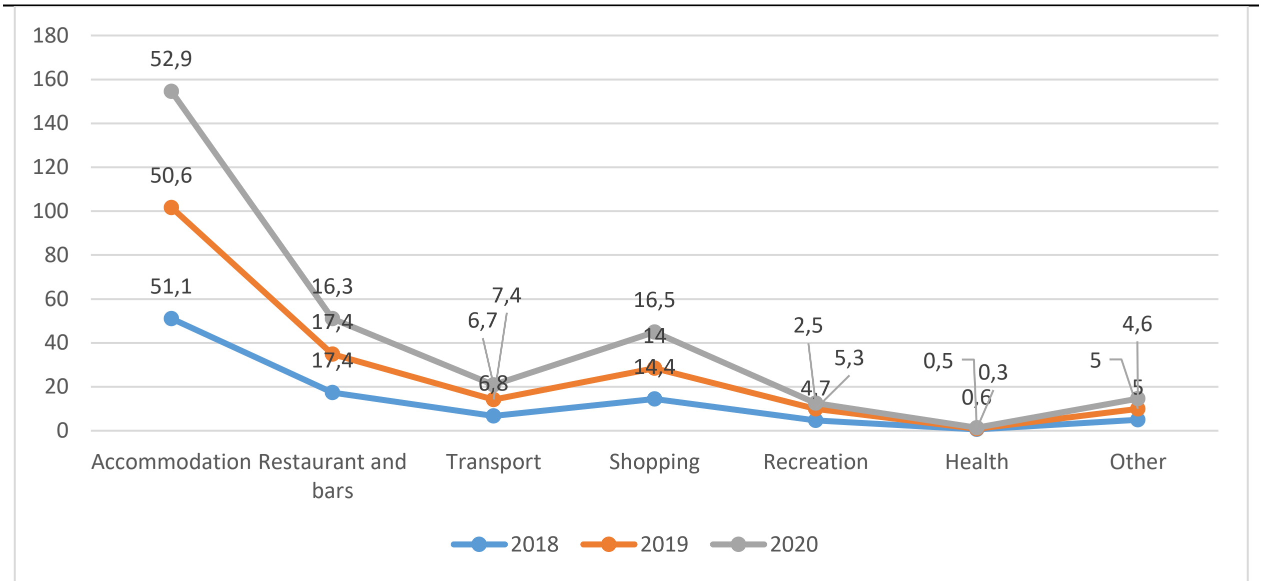

Fig. 10. Situation of individual tourism expenditures, in the fourth quarter, in the period 2018-2020 (%)
Source: own processing [10-14].

For the organization of trips, in the third quarter, those who turned to travel agencies accounted for between 41% (2020) and 47% (2018 and 2019), while tourists who organized their trips individually accounted for between 33%. % (2019) and 35% (2018 and 2020). In the fourth quarter, those who turned to travel agencies had higher shares in the total, between 46% (2018) and 53% (2019). However, the share of tourists who organized their stays individually decreased. In 2019 their share was only 27%, while in 2020 it was 29%.

Table 1. Situation of travel arrangements, in the period 2018-2020 (%)

The organizer of the trip	Quarter III			Quarter IV		
	2018	*2019*	*2020*	*2018*	*2019*	*2020*
Travel agency	47	47	41	46	53	49
Individual	35	33	35	40	27	29
Other forms of organization	18	20	26	14	20	32

Source: own processing [10-14].

Even if at the beginning of the pandemic it was shown that the spread of the Covid-19 virus is favored by the air currents existing in the planes, it is found that the highest share of tourists resorted to air flights to ensure the transport. In 2019, both in the third quarter and in the fourth quarter, the share of tourists who entered Romania through airports increased by 2%, respectively 1% compared to the previous year, while in 2020 their share decreased by 10% compared to 2018 for the third quarter and by 13% in the fourth quarter.

Table 2. Situation of transportation means used for arriving at destination in the period 2018-2020 (%)

The organizer of the trip	Quarter III			Quarter IV		
	2018	*2019*	*2020*	*2018*	*2019*	*2020*
Plane	78	80	68	80	81	67
Car	11	11	26	14	11	29
Bus and coach	9	8	4	4	7	2
Other	2	1	2	2	1	2

Source: own processing [10-14].

At the level of 2020, due to the fact that a large part of the Romanians abroad returned to the country, there is an increase in the share of non-resident tourists arriving by coaches and buses has increased. This was due to both the pandemic and the loss of jobs and financial instability affecting the global population. Regarding business tourism, it also includes participation in congresses, trade fairs, exhibitions, courses. Travel for private purposes included in addition to those for holidays and trips for shopping, visiting relatives or friends, participating in cultural or sporting events, pilgrimages, transit, medical, etc.

In the first quarter of 2021, although the structure of expenditures made by non-resident tourists, by categories, was relatively similar to that of 2018, we find that it registers a value of only 113.60 million lei, to which are added expenditures of 57.91 million lei by individual tourists (Fig. 11).

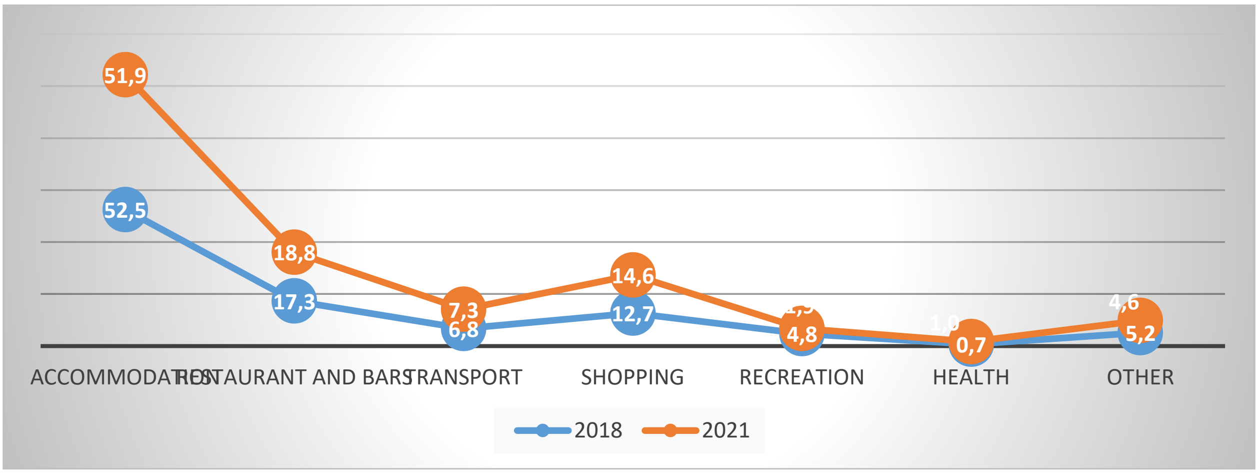

Fig. 11. Statement of expenses incurred by non-resident business tourists, by categories of expenses, in the first quarter
Source: own processing [9].

The expenditures made by private tourists in the first quarter of 2021 compared to 2018 show that the share of accommodation, catering, transport, recreation and health expenses decreased as a share and that the expenditures on various purchases increased as shares, as well as those included in other expenses category (Table 3).

Table 3. Statement of expenses incurred by individual non-resident tourists, by categories of expenses, in the first quarter (%)

Expenditure category	2018	2021
Accommodation	47.9	49.3
Restaurant and bars	15.9	17.6
Transport	5.7	3.6
Shopping	14.8	17.5
Recreation	10.4	6.6
Health	3.2	2.7
Other	2.1	2.8

Source: own processing [9].

The number of non-resident tourists in the first quarter of 2021 was 64,108, of which tourists arriving for business accounted for 69% and 31% individual tourists. Of these, 28% turned to a travel agency, 41% came on their own, 23% through various organizing organizations (unions), and 8% combined several categories of organizers.

Existing data on the Eurostat website show that Romania registered in the third quarter of 2020 the largest decrease in terms of the number of arrivals of non-resident tourists from the European Union [15]. Analyzing the origin of foreign tourists, in 2020, it is found that they came from countries such as Germany (57,400 tourists), Italy (40,100 tourists), France (30,100 tourists), Israel (29,200 tourists) and the United Kingdom (26,900 tourists).

Regarding the number of overnight stays in accommodation units, the decrease in 2020 was almost 90% compared to 2019.

CONCLUSIONS

The Covid-19 pandemic has considerably reduced the number of tourists all over the world. Romania was no exception, so that the decrease in the number of foreign tourists had in absolute values decreases of over 6 million tourists, which made the number of overnight stays of non-resident tourists to represent less than 7% of the total overnight stays. This has negatively influenced the activity carried out both in the tourist reception structures and in other companies providing complementary services that had to either reduce their activity, or re-profile themselves and offer other categories of services, so that they can keep employees. In catering services this was more possible than other types of activities, which required more time to adapt.

Considering the existence of Romania's tourist resources, we consider that a revival of the incoming activity could contribute to the development of this sector of activity, which would lead to the increase of the number of jobs, to the increase of the employment rate, to the development sustainable development of tourist areas, to increase revenues for companies, to increase Romania's visibility, to increase the contribution of tourism to GDP formation, etc.

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STUDY ON CONSUMERS PERCEPTION AND KNOWLEDGE ON VEGETAL ORGANIC BY-PRODUCTS USED AS FUNCTIONAL INGREDIENTS

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Abstract

In recent years the increase in demand and consumption of minimally processed organic products has been more and more desired because of the consumer awareness of a healthier diet, as well as the responsibility for the environment sustainability. Consumers expect a better quality for these organic products compared to conventional ones, thus referring to a lower content of pesticide residues and additives, respectively better nutritional and quality attributes. This study provides a perspective on the consumer behaviour and attitude toward organic food products enriched in value by adding nutrients resulting from the minimally processing of organic fruits and vegetables. The research is based on a survey answered by 547 respondents and which uses a questionnaire designed based on the literature and the conclusions previously obtained in an ongoing research project.

Key words**:** *organic products, minimal processing, functional ingredients*

INTRODUCTION

Worldwide, approximate 30% of globally produced food is lost or wasted at some point along the food chain [8, 15, 17], starting from harvesting and production/processing to handling, distribution and consumption [15]. These facts lead to an inappropriate use of resources, such as freshwater, land, fertilizer or energy used to produce these food products, also contributing to environmental pollution [8, 15]. For the successful implementation of the principles of the circular economy, food waste should be reduced [5]. Under these aspects, food waste could be used, among others, as a sustainable supply of high-value nutrients obtained through green techniques [19].

Fruits and vegetables represent a great source of nutrients, having a series of health benefits, being vital to human consumption [1]. Most consumers are not meeting the daily recommended intake of fruits and vegetables; still the quantity of fruit and vegetable waste is high [3]. Fruit processing contribute with more than 0.5 billion tons of waste globally [4]. The by-products generated from processing could be further processed or treated for obtaining secondary raw materials in the form of functional ingredients [17]. Lately, fruit and vegetable waste presented great interest in obtaining such as flavoring agents, nutraceuticals or bioactive compounds [12]. This fact related to their rich composition in proteins, carbohydrates, lipids and bioactive compounds [11], such as pectin, flavonoids, dietary fibers [4], polyphenols, anthocyanins, etc. Recent research focused on the recovery of fruit and vegetable waste for production of value-added products (functional foods), in order to increase sustainability of healthy diets and to reduce the environmental footprint [3]; the success of developing such products depending on their perception by consumers [16]. Understanding consumer attitudes and preferences, knowledge and behavior is very important for the decision-makers in setting food policies, legislation and research and development directions within society [18]. Considering these aspects, the aim of this study was to determine the consumer perception and knowledge regarding organic food products enriched in value by adding nutrients resulting from the processing of organic fruits and vegetables.

MATERIALS AND METHODS

Marketing research techniques use various methods of investigation that are based on direct information and data, indirect information, and qualitative/quantitative methods. The survey method, the interview method, the focus group method, etc., are some examples of investigation methods. In the present study, the questionnaire-based method was used to process the data and information collected, this method being one of the most used in socio-economic research [10, 6].

Quantitative and qualitative research often uses the questionnaire method because it can provide information on the socio-economic characteristics regarding the attitude and behaviour of the consumer. This method is the most used technique in order to evaluate the factors that influence the consumption behaviour [10, 7, 6].

The questionnaire used in this research study was designed and completed in 2021, between August and September and consisted of interviewing a number of 547 respondents. The questionnaire used was designed based on the scientific literature and on the results obtained in an ongoing research project [2, 9, 13, 14]. The questionnaire includes three sections: the first section is comprised of 7 questions regarding the consumer behaviour of the respondents, the second part has 5 questions regarding the demographic profile, and the third part has 9 questions that are comprised of a multidimensional scale made to measure consumer attitude and preferences towards enriched food products by adding nutrients resulting from the processing of organic vegetables and fruits by-products.

The questions used in designing the questionnaire are closed dichotomous questions, questions with choice answers and open questions, respectively. Closed dichotomous questions are those to which only two answers are available, i.e.: "yes" or "no", "man" or "woman". The questions that have a limited number of answers from which you can choose one are called semi-opened questions, and the opened questions are the ones that the respondents can write their own opinion [6].

To establish the consumer's perception towards the nutritionally enriched organic foods, a set of 9 statements with a metric scale, of the Likert type in five points (total disagreement/disagreement/indecisive/agreement/total agreement) was used. The age of the respondents ranged from 18 to 65.

RESULTS AND DISCUSSIONS

The designed questionnaire on the preferences for the consumption of nutritionally improved organic products was distributed and completed by a number of 547 respondents.

By analysing the obtained data, the survey participants were mostly women (78.4%) aged between 26 and 59 years (76.9%). Furthermore, it can be observed that 236 of them were aged between 26 - 39 and 184 from 40 to 59 years old. As a percentage, this can be expressed as follows: on the segment 26 - 39 years out of the 236 respondents, 75.85% are women, 24.15% men, and on the range 40 - 59 years out of the 184 people, 80.98 % are women and 19.02% are men.

Table 1. Distribution of respondents by age depending on gender

	Men	Women	Grand Total
18 - 25 years	13	56	69
26 - 39 years	57	179	236
40 - 59 years	35	149	184
60 years or more	14	44	58
Grand Total	**119**	**428**	**547**

Source: Own calculation.

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Regarding the education level of the respondents (Table 2), it can be seen that approximately 70% have graduated a college and a master's degree, and 22.22% have a doctorate in the field, while only 9.75% have graduated high school.

Table 2. Distribution of respondents by age depending on education level

	PhD	University	High school	MsC/MBA	Grand Total
18 - 25 years	0.00%	7.41%	2.53%	2.14%	12.09%
26 - 39 years	7.41%	11.50%	2.53%	22.22%	43.66%
40 - 59 years	12.67%	9.94%	3.70%	7.41%	33.72%
60 years or more	2.14%	5.65%	0.97%	1.75%	10.53%
Grand Total	**22.22%**	**34.50%**	**9.75%**	**33.53%**	**100.00%**

Source: Own calculation.

Regarding the respondents' monthly income (Table 3) it can be observed that most of them, 22.84% have a monthly income over 8,500 lei, followed by 18.31% with a monthly income between 2,500 and 3,500 lei, 16.46% between 6,501 and 8,500 lei, while with an income below 2,500 lei are only 6.17% of respondents.

Table 3. Distribution of respondents by age depending on income

	2500-3500 LEI	**3501-4500 LEI**	**4501-5500 LEI**	**5501-6500 LEI**	**6501-8500 LEI**	**>8500 LEI**	**<2500 LEI**	**Grand Total**
18-25 years	4.12%	1.65%	1.65%	0.41%	0.41%	1.65%	1.44%	11.32%
26-39 years	6.38%	6.38%	6.17%	4.94%	7.61%	10.49%	1.65%	43.62%
40-59 years	5.14%	3.50%	4.12%	3.29%	7.20%	9.05%	2.47%	34.77%
60 years or more	2.67%	1.03%	1.85%	1.23%	1.23%	1.65%	0.62%	10.29%
Grand Total	**18.31%**	**12.55%**	**13.79%**	**9.88%**	**16.46%**	**22.84%**	**6.17%**	**100.00%**

Source: Own calculation.

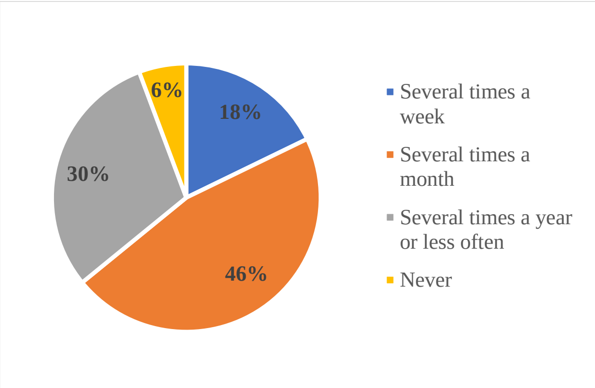

Fig. 1. Frequency of shopping
Source: Own calculation.

Most of the respondents (76.5%) buy certified organic products several times a month/a year or rarely, while 6% do not buy such products (Fig. 1).

In Table 4 it can be seen that no matter the age, 46.34% of respondents consume fortified foods by adding valuable nutrients in the form of extracts, while 5.68% mentioned that they never consume such products.

Table 4. Frequency of consumption of enriched products depending on age

	several times a year or less	several times a month	several times a week	never	Grand Total
18-25 years	3.30%	7.14%	1.10%	1.10%	12.64%
26-39 years	14.84%	19.23%	7.51%	1.65%	43.22%
40-59 years	10.26%	15.38%	6.59%	1.47%	33.70%
60 ani or more	1.83%	4.58%	2.56%	1.47%	10.44%
Grand Total	30.22%	46.34%	17.77%	5.68%	100.00%

Source: Own calculation.

Distribution by age of the answers regarding the use of the information on the product label is presented in Table 5. No matter the age, more than half of the respondents (55.75%) read the entire label, 41.38% read only partial information and 2.87% of them do not read the product label.

Table 5. Distribution of answers regarding the use of the label by age

	totally	**never**	**partially**	**Grand Total**
18-25 years	5.75%	0.29%	6.90%	12.93%
26-39 years	19.25%	2.59%	20.11%	41.95%
40-59 years	21.84%	0.00%	12.36%	34.20%
60 years or more	8.91%	0.00%	2.01%	10.92%
Grand Total	**55.75%**	**2.87%**	**41.38%**	**100.00%**

Source: Own calculation.

The respondents are mostly interested in the ingredient (72.6%) and product expiration date (71.1%), considering that these are the most important information on the product label. More than half of the respondents consider that the origin of the product is important (61.1%) and also the ecological certification (52.3%).

Nutritional information and information about the producer are of interest to less than half of the respondents (45.4%, respectively 40.3%). The fewest of them, about 0.3% are interested in allergens that can be found in the food product (Fig. 2).

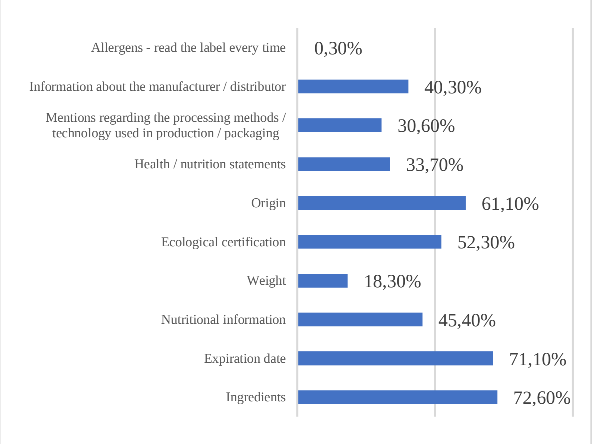

Fig. 2. Food label information
Source: Own calculation.

Among the foods enriched by the addition of valuable nutrients in the form of extracts known by the respondents, bakery products occupy the first place (40.7%), immediately after being dairy products (37.2%). 26.9% of the respondents do not know any food products enriched with nutritional compounds, while 8.6% do not consume such products. Some of such food products known by the respondents (other than the ones stated within the survey) are snack bars, fruit juices and purees, smoothies and food supplements, cereals and yogurts.

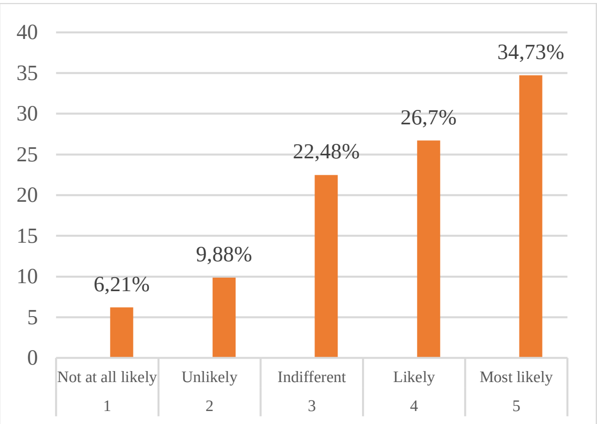

Fig. 3. Probability of buying nutritionally enriched food products
Source: Own calculation.

The probability of buying nutritionally enriched foods (Fig. 3) is of 61.5% (*most likely*, respectively *likely*), while 6.2% of the respondents are *not likely* to buy such products.

When asked about the obligation of to mention on the label the use of waste from the food industry as ingredients, 93% of the respondents agreed with the obligation to mention on the label the use of waste from the food industry as ingredients for food production.

Table 6. The person responsible for the household supply

	Men	Women	Grand Total
Other family members	1.46%	1.65%	3.11%
Both me and other family members	11.15%	41.86%	53.02%
Myself	9.14%	34.73%	43.88%
Grand Total	**21.76%**	**78.24%**	**100.00%**

Source: Own calculation.

43.88% of respondents are the main responsible for shopping for their household, while 53.02% share this task with other family members and only 3.11% depend on other family members (Table 6).

When asked if they heard any promoting campaign of such products, half of the respondents (50.00%) agreed with the fact that these products are not enough promoted and there are no promoting campaigns for them, the distribution on age being 39.19% women and 10.81% men. In a percentage of 24.18%, more precisely 18.13% women and 6.04% men, the respondents consider that these products are promoted enough. The rest of the respondents (25.82%) do not have knowledge about promoting campaigns of such products (Table 7).

Table 7. Consumer agreement/disagreement with advertising campaigns

	Men	Women	Grand Total
Agree	10.81%	39.19%	50.00%
I don't know	4.76%	21.06%	25.82%
Disagree	6.04%	18.13%	24.18%
Grand Total	**21.61%**	**78.39%**	**100.00%**

Source: Own calculation.

Three quarters of respondents, respectively 75.64%, agree that food waste resulting from the processing of vegetables and fruits contains valuable nutrients, such as vitamin C,

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antioxidants, etc. while 6.23% do not agree with this affirmation (Table 8).

Table 8. Consumer agreement / disagreement with the nutrient content of food waste

	Men	Women	Grand Total
Agree	15.93%	59.71%	75.64%
I don't know	3.48%	14.65%	18.13%
Disagree	2.20%	4.03%	6.23%
Grand Total	**21.61%**	**78.39%**	**100.00%**

Source: Own calculation.

Regarding the affirmation of the existence in stores of food enriched by adding nutritional compounds in the form of extracts/powders, the answers are divided somewhat uniformly, on a 3-point scale (agree/don't know/ disagree), respectively, 37.36% agree, 33.52% don't know, and 29.12% disagree (Table 9).

Table 9. Consumer agreement/disagreement with the existence of value-enriched foods in stores

	Men	Women	Grand Total
Agree	7.14%	30.22%	37.36%
I don't know	7.69%	25.82%	33.52%
Disagree	6.78%	22.34%	29.12%
Grand Total	**21.61%**	**78.39%**	**100.00%**

Source: Own calculation.

Approximately 70% of respondents agree that the addition of nutrients to foods resulting from the processing of fruits and vegetables in the form of extracts/powders is a solution to reduce food waste that can help protect the environment. In a percentage of about 10%, the respondents do not agree with this statement, the remaining 20% being neutral (Table 10).

Table 10. Consumer agreement /disagreement with the benefits of food enriched on the environment

	Men	Women	Grand Total
Agree	14.65%	55.13%	69.78%
I don't know	4.40%	16.30%	20.70%
Disagree	2.56%	6.96%	9.52%
Grand Total	**21.61%**	**78.39%**	**100.00%**

Source: Own calculation.

Less than half of the survey participants (44.69%) first consumed foods enriched with valuable components out of curiosity, while 22.71% expressed disagreement with the consumption of such foods (Table 11).

Table 11. Consent/disagreement of consumers with food enriched with valuable components out of curiosity

	Men	Women	Grand Total
Agree	9.89%	34.80%	44.69%
I don't know	4.95%	27.66%	32.60%
Disagree	6.78%	15.93%	22.71%
Grand Total	**21.61%**	**78.39%**	**100.00%**

Source: Own calculation.

About 69% of respondents agreed with the benefits on human health by adding nutrients resulting from the processing of fruits and vegetables to food products, and 8% of them total disagree with this statement (Table 12).

Table 12. Consumer agreement/disagreement with the benefits of food enriched in value on human health

	Men	Women	Grand Total
Agree	14.65%	54.03%	68.68%
I don't know	4.76%	18.68%	23.44%
Disagree	2.20%	5.68%	7.88%
Grand Total	**21.61%**	**78.39%**	**100.00%**

Source: Own calculation.

About three-quarters of survey participants (71.98%) agreed that minimal processing causes the least food changes (Table 13).

Table 13. Consumer agreement/disagreement with changes in minimal processed food enriched in value

	Men	Women	Grand Total
Agree	14.84%	57.14%	71.98%
I don't know	4.95%	15.20%	20.15%
Disagree	1.83%	6.04%	7.88%
Grand Total	**21.61%**	**78.39%**	**100.00%**

Source: Own calculation.

81.5% of the respondents consider that there are few information about fruit and vegetable minimal processing (Table 14).

Table 14. Consumer agreement/disagreement with the existence of information about minimal processing

	Men	Women	Grand Total
Agree	17.58%	63.92%	81.50%
I don't know	1.83%	5.86%	7.69%
Disagree	2.20%	8.61%	10.81%
Grand Total	**21.61%**	**78.39%**	**100.00%**

Source: Own calculation.

More than half of the survey participants consider that they are not sufficiently informed about the products enriched with nutritious compounds resulting from the processing of fruits and vegetables (56.41%) while 26.74% consider that they have sufficient information on this subject (Table 15).

Table 15. Consumer agreement/disagreement regarding the circulation of information on food enriched in value

	Men	Women	Grand Total
Agree	12.64%	43.77%	56.41%
I don't know	2.75%	14.10%	16.85%
Disagree	6.23%	20.51%	26.74%
Grand Total	**21.61%**	**78.39%**	**100.00%**

Source: Own calculation.

CONCLUSIONS

Analyzing the distribution of the sample according to sex, age, income, and studies, we can see that most of them are women, with higher education, aged between 29 - 59 years, with an income of over 4,500 Lei.

Respondents consume certified organic products, and when purchasing such products read the entire information on the package. When reading the information on the label, respondents mainly look at the ingredients, shelf life and origin. Also, they look for information about the manufacturer and about the ecological certification.

Among the consumed foods enriched by the addition of nutrients in the form of extracts, the respondents mentioned bakery and dairy products in the first place.

More than half of the respondents participating in the survey (61.5%) were open to purchasing an enriched food product by adding nutrients in the form of extracts from food waste.

Almost all respondents (93%) said that it is mandatory to mention on the label the use of food waste as an ingredient in other foods. To measure the preferences towards the food products enriched by value by adding nutritious compounds resulting from the processing of organic vegetables and fruits, the respondents participating in the survey expressed their agreement in majority towards the 9 statements. They agreed that minimal processing causes small changes in food, food waste contains valuable nutrients that can be used in the food industry, adding more nutrients to food products is a solution to reduce food waste that can protect the environment and should maintain the human health, there is a clear need for more information about minimal processing methods and functional food.

Foods enriched by the addition of nutrients consumed by survey respondents are mainly bakery products and dairy products that they consume several times a month.

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MOTIVES OF ECONOMIC DECISIONS OF LITHUANIAN AGRICULTURAL ENTITIES TO DEEPEN FARM SPECIALISATION

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Abstract

This study aims at determining the main motives of economic decisions of Lithuanian agricultural entities to deepen farm specialisation. One of the assumptions is that the concentration and dominance of cereals farming is becoming more pronounced in Lithuania. In the course of the research, the methodology of expert evaluation of the motives of agricultural entities and economic decisions to deepen the concentration of economic activities in certain farming sectors was developed. Research was carried out on the basis of these considerations and decision-examination. Upon completion of the expert evaluation, the results of the study are supplemented by the evaluation of statistical data. The specialisation in crop production is strengthening in Lithuania and at the same time displacing the development of animal husbandry. The main motives of that are: the pursuit of profit and stable income, the availability of consulting services, per area payments, access to EU support (in general) and coupled area support. Social motives for deepening the economic activity through specialization more reflect the general motives of farming and living in rural areas as a lifestyle or tradition. The results will serve in making policy and business decisions and other research.

Key words: *specialisation, concentration of farm activity, farmers' decision, farming motives, small farms*

INTRODUCTION

A trend towards farm specialisation as an increasingly relevant strategy for farmers was observed in the more industrialized countries since the middle of the last century [2]. A similar view was held by Bowler [3] in the case of the European Community. He stated that the specialisation, intensification and concentration processes within the farm sector have been associated with regional changes in the agricultural production. Also, he held the stance that "these processes form part of the larger trend towards farm modernisation or industrialisation which has transformed agriculture throughout" (pp. 14). The concept of specialisation and intensification as the means of increasing agricultural production dominated in discourses about agricultural development and modernisation for a fairly long time [9].

According to Bowler [3] the specialisation process in agricultural production begins when individual farmers concentrate their resources of land, labour and capital on a narrow range of products such as cereals, milk or poultry to the exclus. Due to agricultural production specialisation and scale enlargement farming became more capital-intensive [2]. The agricultural intensification essentially "refer to a process whereby inputs of capital and/or labour are increased to raise the productivity or yield of a fixed land area" [28]. Agricultural productivity represents a worldwide goal for agriculture research as a response to growing food, feed and energy demands [1], but effective use of resources is not only about the economic productivity growth on-farm level.

On the other hand, the general trade-offs between intensive agricultural production and the loss of ecosystem services have commented in literature [10; 15; 26; 30; 29]. Agriculture faces the pressure towards adoption of sustainability practices both by policy makers and consumers [1]. However, the long-term changes in the quantity and patterns of ecosystem service delivery in period of considerable agricultural intensification were not mapped and analysed [14] and the interplay of specialization of agricultural production and ecosystem functions and services has not been studied in detail [15].

It should be noted, that the scientific literature highlights the lack of diversification of economic activities as a problem that needs to be addressed, which directly increases the risk of economic activities [8], the relationship between specialization and diversification in farming [20; 21; 12]. A large number of researchers devote themselves to researching the motives of farmers, to engage in agricultural activities in general, e.g. motives of young farmers to start farming [23; 22; 16; 4], motives for setting up new small businesses [13], or higher quality acceptance of claims, e.g. organic farming [25; 27; 12; 19]. In this context, it is not the agriculture specialization itself that is identified as a problem to be addressed, but the scientific problem to be solved is insufficient degree of risk assessment in farming and analysis of factors influencing farming motives to understand farmers' behaviour.

In 2011, the European Commission (EC) has stressed that increasing demand for some resources will eventually lead to shortages and higher prices, which will inevitably affect the European Union (EU) economy. Resources must be used more efficiently throughout their life cycle, from extraction, transport, recycling and consumption to waste disposal. That is why the EC urges resource efficiency. This means creating higher value with lower material costs and other uses and here the farmers' choices and decision are important.

This study aims at determining the main motives of economic decisions of Lithuanian agricultural entities to deepen farm specialisation. One of the assumptions is that the concentration and dominance of cereals farming is becoming more pronounced in Lithuania.

Literature review

High level of agricultural production specialisation allows farms to be technically efficient, acquire highly specific production skills and apply the latest production techniques [9]. Specialization of agriculture is often equated with its intensification or industrialization, which stimulated productivity of labour, land and capital as well as the profitability of agricultural activities [2; 5; 7; 6; 11]. Economic benefits of farm specialization are very closely linked with the presence of economies of scale in agricultural production that results in lower costs per output unit [15]. However, in spite of trends of specialisation and upscaling, farmers' incomes in Europe are under high pressure, due to consequences of changes in the price scissors (the price of industrial goods relative to that of agricultural goods). Farmers' incomes are substantially less than the average income of all professions, even with an important share of farmers' income provided through EU subsidies [11]. Kostlivy and Fuksova [17] found that different types of subsidies can have a different impact on the technical efficiency of farms of different sizes. Staniszewski and Borychowski [24] noted, that subsidies prove to have a significant effect on efficiency only in the case of the largest farms, where efficiency is generally high. High extent of specialisation also leads the farms highly dependent on the commodity market(s) which increasing their economic vulnerability and often compromising their economic sustainability [9]. On the contrary, based on facts or things that the most farms are multi-product farms, Chavas [5] concludes that the benefits of agriculture diversification are significant. He holds the view that these economic benefits are twofold: the reduced cost associated with producing multiple outputs (presence of economies of scope), and the risk reducing effects of diversification.

Moreover, the intensification and industrialization of agriculture gradually violated its previous harmony with the natural environment in such ways as the loss of food, soil, water and biodiversity and air pollution [7]. There is a view that when agricultural specialization increases and moves to broader scales, ecosystem functions can also be endangered at broader spatial scales [15]. Therefore, raising the level of agricultural specialization is one of the main problems of loss and damage to ecosystem services facing, especially in the industrialized agriculture countries.

The developed world has been transferred into the society and economy based on knowledge. We also have to look in that direction. Food production is world-wide business. The increase in total revenues, profit and added values should become primary business motive to all economic entities [25]. Šimpachová Pechrová et al. [23] presented the main motive of young farmers to enter was the wish to continue with farming on the farm of the parents or other relatives and to work in nature and with animals. The hardest was to purchase the agricultural land, administrative burden and ensuring the finances for the development and for start-up. Hence, to facilitate the start-up it is useful to support the land purchase and provide investment subsidies [23]. Min et al. (2017) conducted a research, where found that smallholders with higher risk perceptions specialize in rubber farming less often and are more likely to diversify their land use, thereby contributing to local environmental conservation in terms of agrobiodiversity. The land use choices of smallholder rubber farmers are also associated with ethnicity, household wealth, off-farm employment, land tenure status, altitude and rubber farming experience [20]. Small farms may search for strategies that enable them to increase the turnover by increasing output or decreasing the equity they hold [18].

The primary motive for engaging in organic farming is that the producers want to manufacture safe and healthy food primarily for themselves and for their family members. The purchase of organic seeds and seedlings, as well as of plant protection material and organic fertilizers, is said to be the biggest problem. There are still many other problems, such as a complicated procedure for obtaining certificates of organic production, poorly drafted legislation, the high cost of certification and analyses, low incentives from the government, but also the still low consumer awareness about the importance of organic food. The most important measure for the expansion of organic farming is an increase in government incentives in the form of subsidies or soft loans. It is necessary for the producers to team up into organic food associations in order to jointly meet the demand for organic products in the domestic and international markets [27]. There are many motivations for engaging in or developing organic farming, but in the study of Makutėnienė and Makutėnas [19], the respondents indicated the desire to live a healthy life (75%) and pollute the environment less (67%). Thus, farmers are motivated to protect their own and their family members' health, and their environmental attitudes are strong. As already mentioned, one of the external factors influencing farmers' decision in choosing / developing organic farming is direct support [19]. Hansson et al. [12] study was based on quantitative data obtained from Swedish farmers who self-reported that they ran other ventures in addition to their agricultural production enterprises. Factor analysis revealed a structure with two underlying motives for starting a venture outside conventional agriculture, namely ‘business development for reasons to reduce risk and to use idle resources’ and ‘business development for social and lifestyle reasons’. The factor scores obtained were related to measures of involvement of family members in new activities on farm level. The results showed that the motives for starting new ventures were dependent on the situation of the farm family [12]. Consumer-oriented diversification activities, such as direct sale (“deepening”) as well as tourism services and care farming (“broadening”), are common business strategies of farms within urban areas. Farm characteristics, which encourage the implementation of “deepening” strategies, are: larger farm sizes, high-value production, organic farming, and livestock production. By contrast, the consumer-oriented “broadening” strategies tourism services and care farming prevail on smaller farms and on farms with horses and higher grassland shares. Agricultural extension services increase the odds to diversify the main activities of farms [21].

MATERIALS AND METHODS

The method of expert evaluation is suitable in cases when it is very difficult or practically impossible to apply objective computational or empirical research methods. In the case of this study, the aim is to test the theories spread in the public sphere that concentration or dominance of activities is observed in the cereals sector, which could distort market conditions for other market participants. Expert assessment methods are used to find an effective solution in complex informal situations, solving non-standard problems. The peer review method improves the quality and rationality of decision-making, as experts in a given field can be involved in all stages of decision-making. Expert assessment is understood as a generalized opinion of a group of experts, to which expert knowledge, experience and intuition are applied. This method makes it possible to reconcile the opinions of individual experts and to form a common approach to the problem under consideration.

The study was conducted in several stages. To determine the change in the agricultural specialisation in Lithuania, the following structural indicators were used: the share and growth of output by agricultural products categories at whole agricultural industry and at farm levels; and the share of farms by different types of farming in total farms number. The empirical analysis of agricultural specialisation at national level is based on two EUROSTAT's databases such as Economic accounts for agriculture data for 1995-2020 and Farm structure survey in 2005 and 2016 data. FADN data for 2005-2019 were used for the analysis of changes in agricultural specialisation at farm level.

In the second stage, analysis of the scientific literature was carried out in order to single out the factors that may influence the decisions of farmers. The analysis of scientific sources, supplemented by the content analysis of the specialised press sources, professional agricultural publications. The analysis was carried out according to keywords such as "concentration of agricultural activity", "diversification", "barriers to diversification", "farmers' motivation to engage in certain activities", "farmers' decisions in farming" etc. This allowed to identify factors that could influence farmers' motives to start, change, diversify or concentrate farming activities in particular agricultural sub-sector. All the factors identified during this desk study were summarized and grouped. All factors were grouped according to their nature and three main groups of farming motives were distinguished. In this way, groups of economic, social and environmental factors formed. Based on this breakdown, a questionnaire for experts was developed.

The economic motives listed in the scientific literature and other sources reviewed were the most numerous. They were divided into two additional groups, the first group included factors related to the current situation of the farm and its environment, the decisions of the farm manager, and the second group combined factors arising mainly from the financial situation of the farm and state interventions in the agricultural sector. These factors are identified as financial. In this way, a system of four groups of factors formed.

During the third stage the pilot study was carried out. During the pilot phase of the questionnaire, several randomly selected experts were asked to submit their suggestions for improving the questionnaire. Experts who participated in the pilot phase unanimously replied that environmental factors do not have a significant impact on the concentration or diversification of farm activities and are more confusing than beneficial in the expert assessment. Environmental factors, in expert opinion have a limiting value on the concentration of farm activities, and experts were confused about the need to provide an estimate for each environmental indicator, often chose a neutral value for the estimation. Therefore, it was decided to exclude environmental factors from further evaluation. It can be concluded from the answers of the experts that environmental requirements are important for the economy insofar as their norms are mandatory and the impact is more neutral. Crop rotation requirements could be of greater importance to avoid soil degradation and monoculture cultivation.

Based on the above information, a questionnaire for expert evaluation was developed. Experts were asked to score each factor to what extent it contributes to the deepening of economic activities through specialization, increasing the concentration and dominance of activities in a particular field of farming, on a scale from 1 to 5 points, where 1 – does not contribute at all; 2 – does not contribute; 3 – neither contributes nor contributes; 4 – contributes; 5 – contributes greatly. The questionnaire was supplemented with two open-ended questions in order to find out whether farms in Lithuania tend to diversify their activities and what they see as possible main obstacles to diversification of economic activities. The open-ended questions were selected to assess those possible aspects that may have been omitted in the groups of factors presented, allowing the experts to provide their additional insights into the topic under consideration.

In the fourth phase, an expert evaluation was carried out, involving experts from different fields. An expert in this case is a specialist with knowledge and experience in a certain field (latin “*expertus*” – experienced) in the agricultural sector. The professional competence of an expert is important for the solution of the problem, which is called the competence of an expert in the methodology of expert evaluation research. An individual expert evaluation method of active interviews was used. The experts did not consult each other and did not know what was included in the study, evaluated the submitted questionnaire individually from the position of the farming field or institution/union/ association they represented.

The expert evaluation was attended by experts from the Chamber of Agriculture of the Republic of Lithuania, the Lithuanian Young Farmers and Youth Union, the Lithuanian Association of Agricultural Companies, the Lithuanian Grain Growers' Association, the Lithuanian Farmers' Union and the Kaišiadorys District of the Lithuanian Farmers' Union. Institutions for expert evaluation were selected from organizations representing the Lithuanian agricultural sector. Their participation was voluntary and unpaid. 3 experts participated in the pilot phase of the study. In the final phase, the study presented and summarized the evaluation results of six experts from different institutions.

The experts and the bodies they represent have been selected in such a way as to maintain the principle of impartiality and to obtain a comprehensive and integrated assessment. The institutions interviewed and the experts appointed by them represent all agricultural subsectors, with different groups of farms, both existing and emerging farms. It was planned to interview more experts representing specific fields of farming (organic farming, horticulture, dairy farming, animal husbandry, etc.), but this idea was rejected, because the study assumes the study of concentration processes in cereal farms and the listed types of farming are often opposed to crop cultivation activities so it could affect the final results. It was presumed, that the latter experts would be interested in highlighting the existence of concentration in the crop sector. In order to extend the study, it could be completed by involving the proposed experts from additional sectors, but then the problem should be formulated more broadly and the tendency of Lithuanian farmers to specialize/concentrate their activities in different agricultural subsectors should be examined.

The expert evaluation (including the pilot phase of the survey) was conducted from 31 August 2020 to 6 November 2020. Experts were contacted by telephone and, for their convenience, the questionnaire was sent to them in addition by e-mail. The experts had additional time to familiarize themselves with the submitted questionnaire and provided their answers and estimates after reflection. This avoid an imprompt, emotional or careless assessment if you are asked to answer the questionnaire immediately by phone without giving an extra time to reflect on the problem.

RESULTS AND DISCUSSIONS

Lithuania has a diverse agricultural sector, producing a range of crop and livestock products (Fig. 1). The mix of agricultural production is determined by soil type, climate, the historical traditions of agricultural activity, proximity to markets and agricultural policy. However, output gains have varied widely among different crops and livestock sectors in the last quarter of a century.

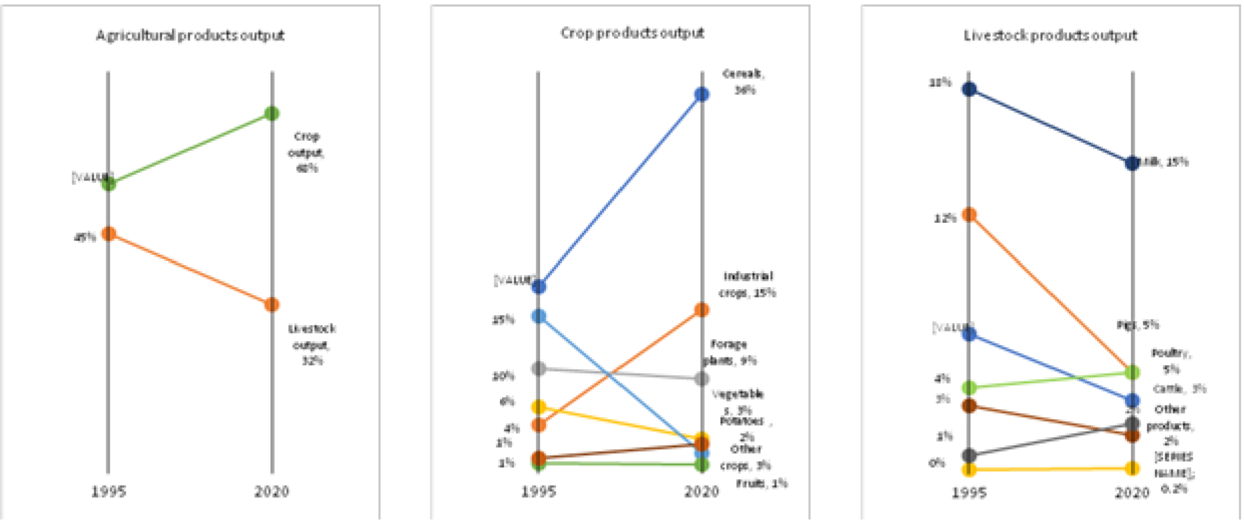

Fig 1. Changing national specialisation in agricultural production 1995-2020 in Lithuania (share of total agricultural output by products categories)
Source: own composition based on the Eurostat data: Economic accounts for agriculture.

During the last quarter of a century, production of cereals and industrial crops (oilseed crops) are the fastest growing segments and now together contribute 51% of the total agricultural products output, outstripping more than doubled their historical share (22%) a quarter of a century ago (Fig. 1, middle panel). On the contrary, forage plants, vegetables, potatoes and fruits production fell sharply (about 50-55%) at the same time.
In volume terms, crop production has increased more than 2.7 times, while livestock production has increased only by 14%. Upon examining the increase volume outputs of over the long-term by crops product categories in greater detail (Fig. 2, left panel), were find that only a few products account for most of the increase and the concentration of crop production. There also continue to be stark differences between crops and livestock production. Volume of production of most livestock products fell, with the exception poultry meat and eggs (Fig. 2, right panel) and now collectively accounts for less than a third of the total agricultural products output.

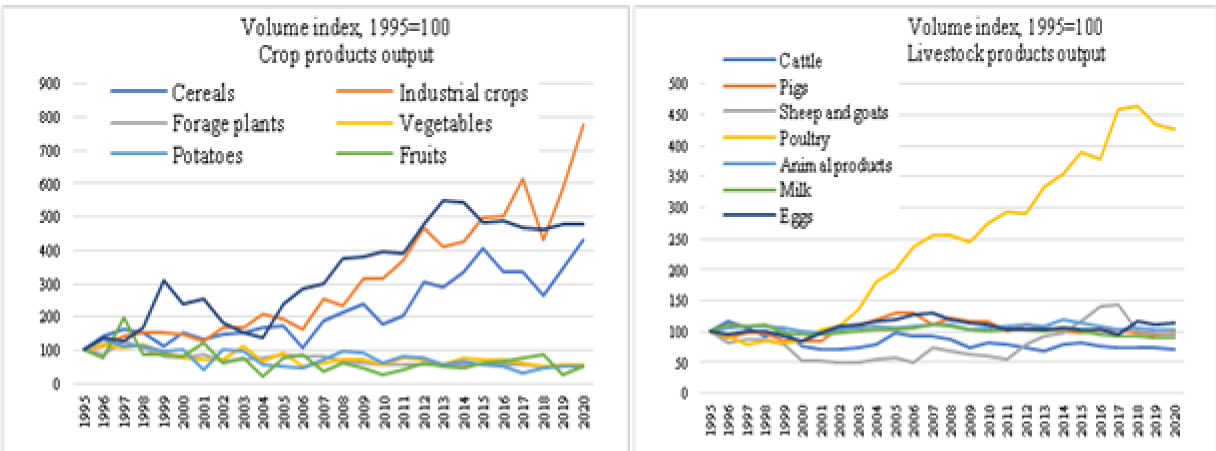

Fig. 2. Cumulative growth of output by agricultural products categories 1995-2020 in Lithuania
Source: own composition based on the Eurostat data: Economic accounts for agriculture.

In the structure of Lithuania's farms by types of farming, the biggest changes to the farm population over the last fifteen years been an increase in the share of crop-specialist farm businesses and a decline in the share of mixed farm businesses. As shown below (Fig. 3), specialisation in Lithuanian agricultural sector is exemplified by a strong increase in the proportion of farms specialised in cereals, oilseed and protein crops sector from 2% in 2005 to 22% in 2016, outstripping the historical domination of specialised dairy farms. At the same time in farm structure, have seen a dramatic decrease the share of mixed livestock farms (by 20 percentage points) and mixed farms that combine crops and livestock farming (by 10 percentage points).

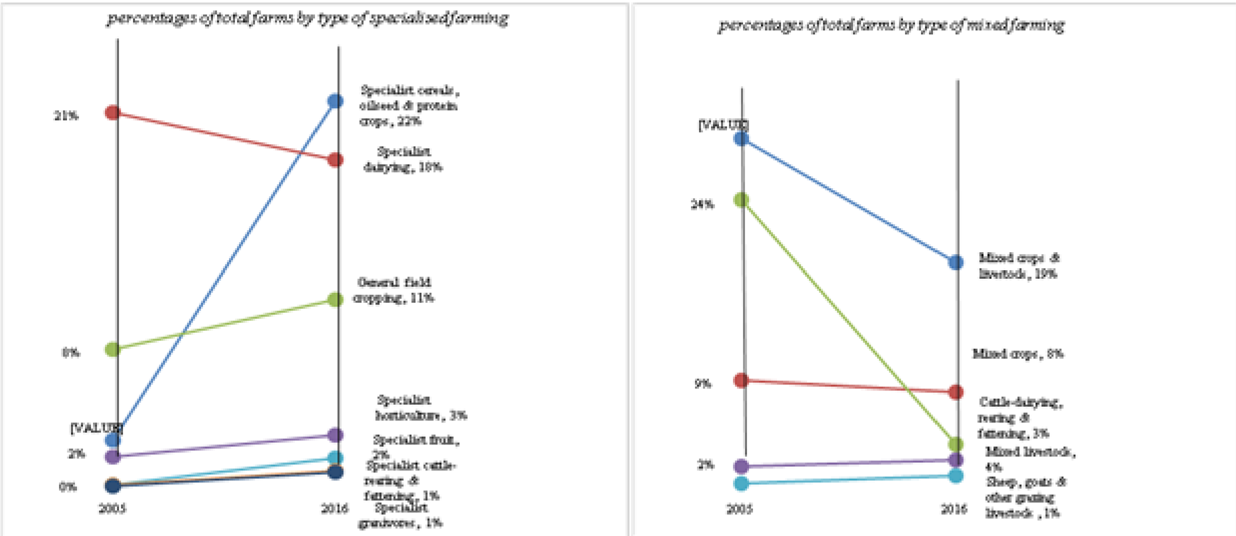

Fig. 3. Changing proportion of farms by different types of farming 2005-2016 in Lithuania
Source: own composition based on the Eurostat data: Farm structure survey.

Upon examining the structural change of total farm output over the long-term across different farm classes in greater detail by crops and livestock product categories (Fig. 4).

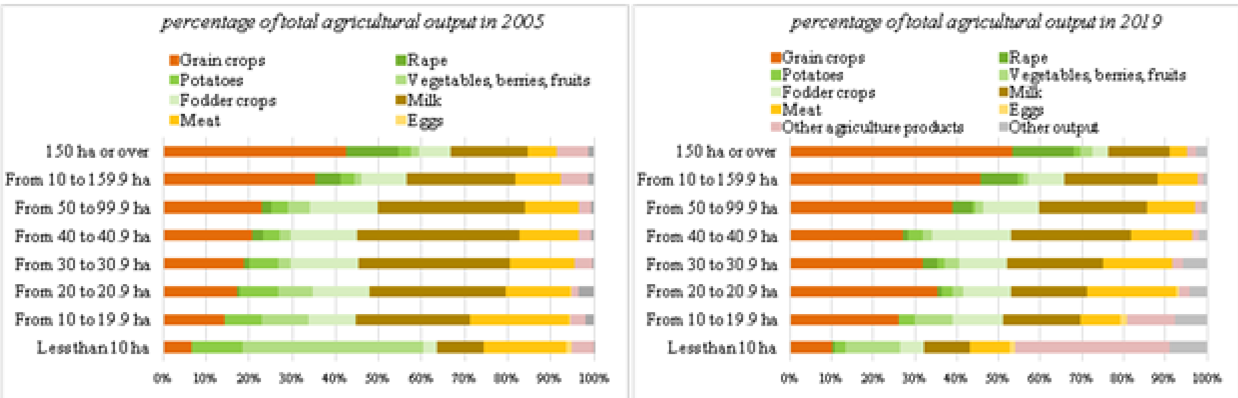

Fig. 4. Changing farms' specialisation in agricultural production across different farm classes 2005-2019 in Lithuania (share of total agricultural output by products categories)
Source: own composition based on the FADN data.

In Fig.4, we may find that, the share of crop production has increased in all physical size classes of farms except the smallest farms class. Only two crops products account for most of that increase and the concentration of production: i.e. grain crops and rape. The combined share of both products increased by 13-19 percentage points across different farm size classes, with the exception of small-scale farms (less than 10 ha) and medium - sized farms (from 40 to 40.9 ha), where this share increased by 4 and 5 percentage points respectively. On the contrary, in small-scale farms class, the share of share of both grain crops and rape fell by a tenth, while the share of various other crop products increased dramatically by almost a third (i.e. 32 percentage points). As for the development of livestock production over the same long period, a fell in the share of milk production was observed in all farm size classes, and the largest fell were in the two farm size classes (from 20 to 20.9 ha and from 30 to 30.9 ha) by 12 percentage points in each. The share of meat output increased by 7 percentage point in only one farm size class from 10 to 19.9 ha).

Moving on to the results of the expert evaluation, five out of six experts, answering the question whether they notice manifestations of deepening the concentration/specialization of agricultural activities in Lithuania, when economic entities expand their activities in one direction of farming, noted that they see such a trend (Fig. 5). It was pointed out that the concentration of activity in crop production was noticeable, followed by cattle farming, as well as the poultry and pig farming sectors.

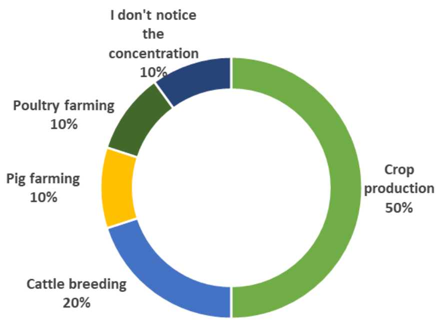

Fig. 5. Lithuanian agricultural sectors, where experts notice the concentration of activities
Source: own elaboration based on expert evaluation.

Only one in six experts noted the lack of concentration through deepening activities in certain farming sectors and pointed to a natural redistribution of business in search of opportunities to make more profitable use of existing infrastructure. Farmers running farms are looking for opportunities in the beef cattle or poultry sectors, with larger or smaller areas of land looking for opportunities for crop development. Another expert supplemented these insights by noting that concentration occurs in all branches, but the observed intensity of the process varies.

The following are expert evaluation estimates for different groups of factors, with each expert assigning scores to each factor, the average of the estimates provided is calculated, giving the different experts the same weight.

Among the **economic motives of Lithuanian agricultural entities to deepen their economic activity through specialization**, increasing the concentration of activity in a certain field of farming, three main motives dominate: the pursuit of profit, the pursuit of stable income and the availability of advisory services (Fig. 6).

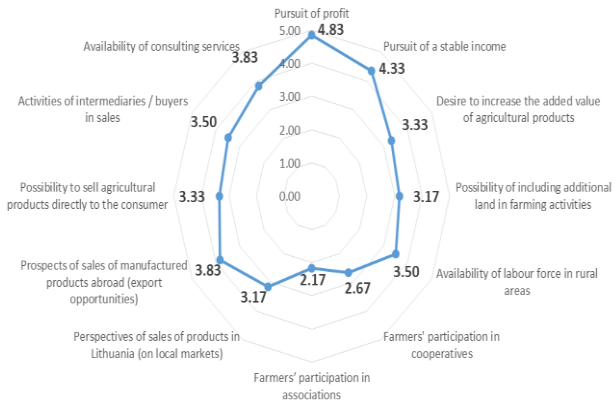

Fig. 6. Assessment of economic motives of Lithuanian agricultural entities to deepen their economic activity through specialization, increasing the concentration of activity in a certain field of farming, average score
Source: own elaboration based on expert evaluation.

Among the factors that **do not affect the increase of the concentration of activities in a certain field of farming**, experts noted the participation of farmers in the activities of associations or cooperatives, which should be a serious signal for the further development of cooperative activities among farmers. Theoretically, cooperation should contribute to increasing the specialization of individual farm groups and achieving economies of scale. Also, it can be seen that Lithuanian experts evaluated advisory services that contribute to increasing the concentration of activities, which is in contrast to the experience of other countries, when training and advisory activities are focused on risk management and diversification of farm activities.

Among all the **financial instruments that contribute most to increasing the concentration of economic activity**, the most important are: direct area payments, access to EU support (in general), greening payments and coupled area payments for vegetables, fruit, berries, protein crops, sugar beet, seed potatoes and growing cereals from certified seed) (Fig. 7). In general, all financial instruments contributed to the concentration of farm activities in a particular farming direction. This is linked to area payments and crop cultivation.

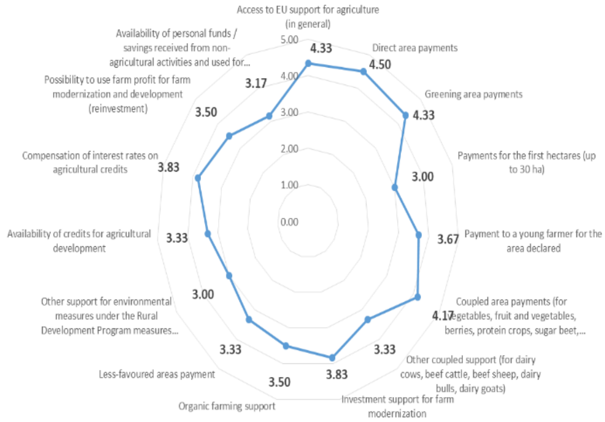

Fig. 7. Contribution of financial instruments available to Lithuanian agricultural entities to the deepening of economic activities through specialization, increasing the concentration of activities in a certain field of farming, average score
Source: own elaboration based on expert evaluation.

Taking into consideration the **social motives for deepening economic activity through specialization**, increasing the concentration of activity in a certain field of farming, three main ones are identified: 1) available farming experience and knowledge, 2) available managerial/entrepreneurial skills and 3) aspiration to create a job when working on a farm is the main source of livelihood (Fig. 8). There are no social motives that, according to the general expert assessment, would be identified as completely irrelevant to the concentration of economic activity. But it should be appreciated that social motives are more reflective of the general motives for carrying out farming activities, i.e. the desire to create a job for oneself, and the chosen activity usually depends on the available farming experience and available knowledge and skills.

Fig. 8. Social motives of Lithuanian agricultural entities to deepen their economic activity through specialization, increasing the concentration of activity in a certain field of farming, average score
Source: own elaboration based on expert evaluation.

When asked whether farms in Lithuania tend to diversify their activities, expert opinions differed, but most agreed that the level of diversification was not sufficient but still was an important as main risk management tool or an opportunity to supplement seasonal income. According to the representative of Lithuanian young farmers and the Youth Union, the level of diversification of farming activities in Lithuania is really low, but it is necessary to ensure higher and more stable income from the agricultural sector and to manage risks. There is a lack of education and training on the economic benefits of a diversified economy.

The Lithuanian Grain Growers' Association emphasized that due to the high seasonality (in the grain, horticultural sectors, etc.), farms are looking for activities that could be carried out of season. Extensive livestock and poultry farming directions are chosen.

Representatives of the Chamber of Agriculture noted that farm diversification occurs when new farmers or young farmers come to the countryside, looking for and finding new activities, taking into account the experience of other countries – they chose good and attractive examples, participation in

educational programs, trainings, exhibitions, etc. Farms of young farmers are established by taking over farms from parents and changing activities, e.g. from dairy cow breeding to beef cattle breeding, sheep breeding, poultry breeding, etc., new branches of crop and berry growing are emerging, sometimes also focused on processing – blueberries, quinces, sea buckthorn, nuts, etc.
According to the Lithuanian Farmers' Union, diversification of activities allows to reduce business risk, distribute production means and workload more efficiently. Diversification of activities manifests itself in all branches, first of all in the chosen specialization by searching for niche products, for the production of which most of the already acquired machinery, equipment or structures can be used, existing knowledge and experience are applied (this is the cheapest way of diversification). Another process of abandoning narrow specialization and switching to mixed farming or choosing to develop alternative non-agricultural businesses is also observed. This direction of diversification is more often driven by more financially capable farms, which have the opportunity to adequately finance the need to modernize production processes, are able to manage several farm activities at the same time.
Main obstacles to economic diversification of farm activities are: lack of funds, necessary investments to start new activities, unstable purchase prices of livestock (especially dairy), lack of professional knowledge and practical skills, lack of specialized consultants (narrow areas and deep knowledge of specific subjects), poor farmers cooperation, unfavourable political situation, negative public attitude towards farming, new markets for products are needed, and farmers lack marketing knowledge. A representative of the Lithuanian Young Farmers and Youth Union expressed the initiative that many young farmers could create new jobs in order to process the products grown on the farm, but there is a lack of funds for this. Cooperation could be useful here, but incentives are needed, such as support for cooperative farms only. Training and counselling on the benefits of cooperation, risk management and collaboration are needed. Experts unanimously argued that diversification of activities requires a lot of specific knowledge from different fields, lack of experience, and lack of skills makes it more difficult to manage production and marketing processes.

CONCLUSIONS

Analysing the long-term period, the specialisation in crop production is strengthening in Lithuania and at the same time displacing the development of animal husbandry. It is important to emphasize that significant differences remain between the specializations of farms of different farm sizes, where large farms are specialized in growing cereals and small farmers are engaged in more diversified activities.
In the expert assessment, the experts not only identified the cereals sector, where concentration processes are being monitored, although this sector has been mentioned the most, but it is not less important to focus on other sectors such as livestock, poultry and pig production to those farms that are narrowly specialized.
The results of the research showed that the main motives of Lithuanian agricultural entities to deepen their economic activity through specialization are the pursuit of profit and stable income, the availability of consulting services, per area payments, access to EU support (in general) and coupled area support.
Social motives for deepening the economic activity through specialization more reflect the general motives of farming and living in rural areas as a lifestyle or tradition.
Experts unanimously agreed that diversification of economic activities can benefit the economy as a means of risk management, income support. However, farms choose the direction and extent of diversification based on their available resources and financial capacity. The biggest breakthrough in diversification of agricultural activities is expected from young farmers who come to the sector with new ideas.

The study of the impact of environmental requirements on farming motives should be addressed in the further study, which would allow a detailed assessment of the impact of the latter requirements on farmers' decisions.

ACKNOWLEDGEMENTS

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ANALYSIS OF THE SOCIO-DEMOGRAPHIC STATE OF RURAL AREAS IN THE SYSTEM OF THEIR SUSTAINABLE DEVELOPMENT: A CASE STUDY OF UKRAINE

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Abstract

In the article we have substantiated and conducted statistically assess the impact of the final results of economic activity on the current socio-demographic situation of rural areas in Ukraine. Based on the results of determining the influence of conditioned factors on the level of labour migration of the rural population in Ukraine, we have developed a regression equation. Also, based on the results of the study, we built two cartograms, comparison of which provides an opportunity to assess the dynamics of the formation of the total fertility rate in rural areas (per 1 woman) for 2016 – 2020. We built a cartogram that visualizes the results of grouping regions of Ukraine by natural increase, decrease population in rural areas of Ukraine. The results of our study provide an opportunity to confirm that in the context of Ukraine's official accession to the European Union and the serious challenges of today, the Ukrainian state should perform the functions of regulating the most important spheres of society in general and rural areas in particular. The task of increasing the employment of the rural population should be raised to the level of state priorities, which would provide an opportunity to create new jobs for the rural population in industries that can provide the maximum competitive effect.

***Key words*:** *socio-demographic state, rural population, sustainable development, rural areas*

INTRODUCTION

The transformation of approaches to the formation of a new agricultural policy in Ukraine, which took place in the process of concluding an association agreement with the European Union, has significantly raised the issue of ensuring sustainable development of rural areas. In turn, the reform of the local self-government system, which has led to the creation of united territorial communities, as well as budgetary decentralization, allows rural areas to rely on additional resources that can be used to improve the socio-economic situation in general and achieve sustainable development goals in particular. The critical problem that needs to be urgently addressed in this area now is the formation of an effective organization of agriculture and the improvement of the new administrative system, as the former ways of organizing the socio-economic development of rural areas were not functional.

It should be noted that the main features of the current stage of development of rural areas in Ukraine are characterized by the presence of specific aspects of their functioning, formed in previous years under the influence of external and internal factors at the macro and micro levels. Such features include demographic problems, which are the reduction of the rural population, strengthening of external migration processes, the transformation of the social base and infrastructure of the village. In the economic aspect, the characteristic changes that occur in rural areas are the growth of the share of personal households in agricultural production, intensive development of rural tourism, and so on. However, the main task that needs to be urgently addressed in the process of formulating a policy of sustainable development of rural areas is the general improvement of the socio-economic situation of the rural population in Ukraine. The solution of this problem is connected with the formation, modelling, and development of rural territorial communities in Ukraine, as well as with ensuring the proper stability, reliability, and efficiency of the functioning of administrative structures of local self-government in rural areas as systemic formations of increased complexity.

The study of socio-economic and demographic development of rural areas is one of the problems that are relatively widely covered in the scientific literature. However, a significant part of research on this issue is related to the development of the agricultural sector. Researchers such as O. Agres [1], I. Balaniuk [4], A. Boiar [7], O. Buhutskyi [8], Y. Chaliuk [9], T, Kulinich [17], V. Onykienko [19], A. Popescu [22-34], P. Sabluk [36], R. Sodoma [41-43], I. Yakoviyk [50], O. Yatsukh [52] and others. In addition, a significant contribution to the development of scientific-applied, structural-functional, and methodological aspects of solving problems of ensuring the efficiency of rural areas, made in the scientific works of such researchers as O. Apostolyuk [2], O. Binert [5], O. Bitter [6], M. Dziamulych [10-12], E. Libanova [18], J. Ostafiichuk [20]. T. Shmatkovska [38-40], O. Stashchuk [45-47], Ya. Yanyshyn [51], I. Zhurakovska [54] However, despite the relevance and theoretical and practical value of the research, some issues related to the effectiveness of socio-economic policy for rural development need to be improved.

MATERIALS AND METHODS

To study the socio-demographic condition of rural areas, it is necessary to use specific tools of demographic analysis, which will identify key aspects of natural and migratory population movements. The most effective methods in this aspect are indicators of socio-demographic statistics, suitable for cartographic reflection of demographic trends in rural areas.

Accordingly, in our study, the main indicators used in the analysis were the following:

1. Natural increase (decrease) per 1,000 persons of the existing population (total natural increase (decrease)), which is the ratio of natural increase (decrease) of the population to the average annual population or the difference between the total birth and death rates:

$$R_{ng(r)} = R_f - R_m \quad (1)$$

where: R_f – total fertility rate per 1,000 population;

R_m – overall mortality rate per 1,000 population.

2. The total fertility rate per woman in a given period. This indicator allows us to estimate the potential average number of births by one woman during her actual reproductive period, provided that the baseline birth rate remains unchanged for those years that fall into the analyzed period and for which there are age coefficients. This ratio can be determined by calculating the total amount of the corresponding age-specific fertility rates.

3. The share of the rural population in the total population of the region, %:

$$S_{rp} = \frac{P_r}{P_w} \quad (2)$$

where:

P_r – number of rural population;

P_w – total population.

4.Migratory increase (decrease) in population:

$$M_g = A - D \tag{3}$$

where:
A – the total population that arrived in the region;
D – the number of people who left the region.

5.Total migration growth rate (decrease) (migration increase (decrease) per 10,000 people of the current population):

$$M_{gt} = \frac{P_m}{P_a} \tag{4}$$

where:
P_m – migratory population growth over a period of time;
P_a – the average number of available population.

The processes of relationships and interdependencies can be studied using appropriate methods and models. To identify the relationship between factors and performance traits, we used the method of correlation-regression analysis. Correlation-regression analysis is one of the main statistical methods for studying the dependent random variable Y on random variables X. This method is used when the observation data can be considered random, unbiased, and typical. They are formed from the general population, which is distributed according to a multidimensional normal law. Indicators of correlation, which are calculated for a limited set, are only estimates of a statistical pattern. At the same time, it is necessary to consider that in any set the element which is not completely repaid by chance remains. Therefore, a statistical assessment of the degree of accuracy and reliability of the correlation and regression parameters is required [15].

The application of these methods involves the analysis of the studied indicators of demographic statistics and the construction of a mathematical model based on the results. In this case, a significant number of factor values necessitates the use of methods of multiple correlation-regression analysis, which allow to identification of the most statistically significant factors and assess their relationship with the resulting trait. The interaction of the resulting indicator (Y) with the factor features (X_1, X_2….X_n) is determined on the basis of the linear multifactor regression equation according to the following formula:

$$Y = a_0 + \sum a_i x_i \tag{5}$$

where:
a_0 a_i – estimates of unknown deterministic parameters, where i is the number of parameters;
x_i – factor (independent) features, regressors, where i – the number of features.
i =$\overline{1; n}$.

The analysis was performed by us according to the official statistical data on the regions of Ukraine for 2020, which were processed in the software product Statsoft STATISTICA (Multiple Regression program module).

RESULTS AND DISCUSSIONS

We believe that the study of the relationships between the main macroeconomic, social, and demographic indicators of rural development in terms of sustainable development requires modelling and further comprehensive research. Thus, the aim of the article is to statistically assess the impact of the final results of economic activity on the current socio-demographic situation of rural areas in Ukraine.

Socio-demographic processes in the country should be considered as complex, consisting of components of different areas of social activity of the geopolitical complex.

It is the systemic approach that provides an opportunity to present the socio-demographic situation of rural areas of the country as a system. In order to define and characterize it, it is necessary to build a system model that to some extent reflects the first and contains only the most characteristic indicators that evaluate it. The system model cannot be absolutely adequate to the system reality, because it is not able to reproduce all the details of the complex process of market functioning. Since it is a static model that only captures (registers) the real process, a third system is needed: a modelling system, which is a process that provides the ability to accurately reflect the system reality in the system model. The more perfect the modelling system, the more fully it is possible to reflect the real market relations in the system-model of socio-demographic development of rural areas at the present stage [13; 35; 37; 44].

The set of methods that are most often used in the analysis, focus, as a rule, on solving two problems: proving the homogeneity of the modelled processes (variation statistics) and determining the extent of their relationship (correlation and methods of generalizing indicators). The main requirement of statistical research is the study of mass data. However, the practice of using statistical methods in modelling is often limited to the study of mostly isolated cases. Hence the contradictions: designed to study mass phenomena - statistical methods are artificially used to study individual cases. Therefore, sometimes in modelling, statistical methods are replaced by mechanical ones or statistical methods are used only as illustrative material [3]. The way out of this situation can only be in the use of mass statistical, focused on scientific methods, arrays of information.

To determine the relationships between economic, socio-demographic factors of rural development and their statistical evaluation, we have chosen a system of relevant indicators.

Economic factors of rural development are represented by the following indicators: gross value added per capita, thousand UAH; unemployment rate,%; level of environmental pollution in terms of emissions of harmful substances into the atmosphere by stationary sources of pollution by region, thousand Socio-demographic indicators of rural areas are represented by the following system of indicators: migration processes among rural workers; the general birth rate in rural areas; general increase in the rural population due to natural factors. The analytical basis for the calculations was the official static data of the State Statistics Office of Ukraine for 2020 [48].

Socio-demographic indicators of rural development include, first of all, indicators of natural and mechanical movement of the rural population. Labour migration of the rural population as a component of the mechanical movement largely reflects the features of the rural labour market in Ukraine, the level of rural employment, and unemployment, which are a consequence of historical, social, and economic conditions prevailing in Ukraine for many decades. The changes taking place in the economic system of the state also require appropriate changes in the system of social and labour relations and guarantees of workers' rights. In this aspect, it should be noted that in Ukraine there is a not very perfect labour market of the rural population, which is due to the specific causes of the process of changing property relations in rural areas. At present, there are significant problems associated with ensuring the regulatory impact and infrastructure development of this market. As a result, there are objective problems associated with ensuring the appropriate level of socio-economic development of rural areas.

The outflow of the most active part of the youth abroad is undesirable and is considered a rather dangerous risk for national development as a whole. This can be a significant problem for Ukraine, because, firstly, it will complicate the staffing needs of domestic agricultural producers, and secondly, in the context of demographic problems in rural areas will reduce the resilience of national social systems, including pensions and more [14].

In the process of studying the relationship between the level of labour migration of the rural population and a set of relevant economic factors, we used correlation-regression analysis. Based on the results of this study, we built a correlation-regression model and tested it for representativeness and adequacy.

$$Y = 5.9474 - 0.0572x_1 + 0.2843x_2 + + 0.0068x_3 \quad (6)$$

Analyzing the obtained regression equation, we can say that the greatest influence on the performance indicator is exerted by factor X_2, namely, the level of rural unemployment. It was found that if the level of rural unemployment increases by 1%, the level of labour migration of the rural population will increase by 0.28%. The third factor (X_3) has the least significant impact on the performance indicator. in particular, according to the results of the study, it was found that with an increase in the level of environmental pollution by 1 thousand tons, the level of labour migration of the rural population in Ukraine increases by only 0.007%.

Regression coefficients are numbers that are determined in actual units (in natural scale) and are therefore incomparable with each other. To transform them into relative indicators, we used the same transformation to obtain the pair wise correlation coefficient. The value obtained is a standardized regression coefficient or β-coefficient.

Table 1. Indicators of correlation-regression analysis on the impact of factors on the level of labour migration of the rural population of Ukraine in 2020

Factors	BETA coefficients	Standard error of BETA coefficients	Regression coefficient (B)	Standard error B	t- criterion	Actual materiality level (p-level)
X_1	-0.375623	0.354781	-0.0572	0.437921	-1.36011	0.045287
X_2	0.570515	0.354781	0.2854	0.437921	0.34254	0.031683
X_3	0.120642	0.354781	0.0069	0.437921	0.77716	0.703265

X_1 – GDP per capita, thousand UAH;
X_2 – level of rural unemployment, %;
X_3 – level of environmental pollution, thousand tons.
Source: own development.

According to the results of our study (Table 1), it was found that the β-coefficients for the three factors analyzed, respectively, are: -0.3755; 0.5704; 0.1206. The coefficient of determination = 0.311, ie only 31.1% variation in the level of labour migration of the rural population of Ukraine in the study period is explained by three factors.

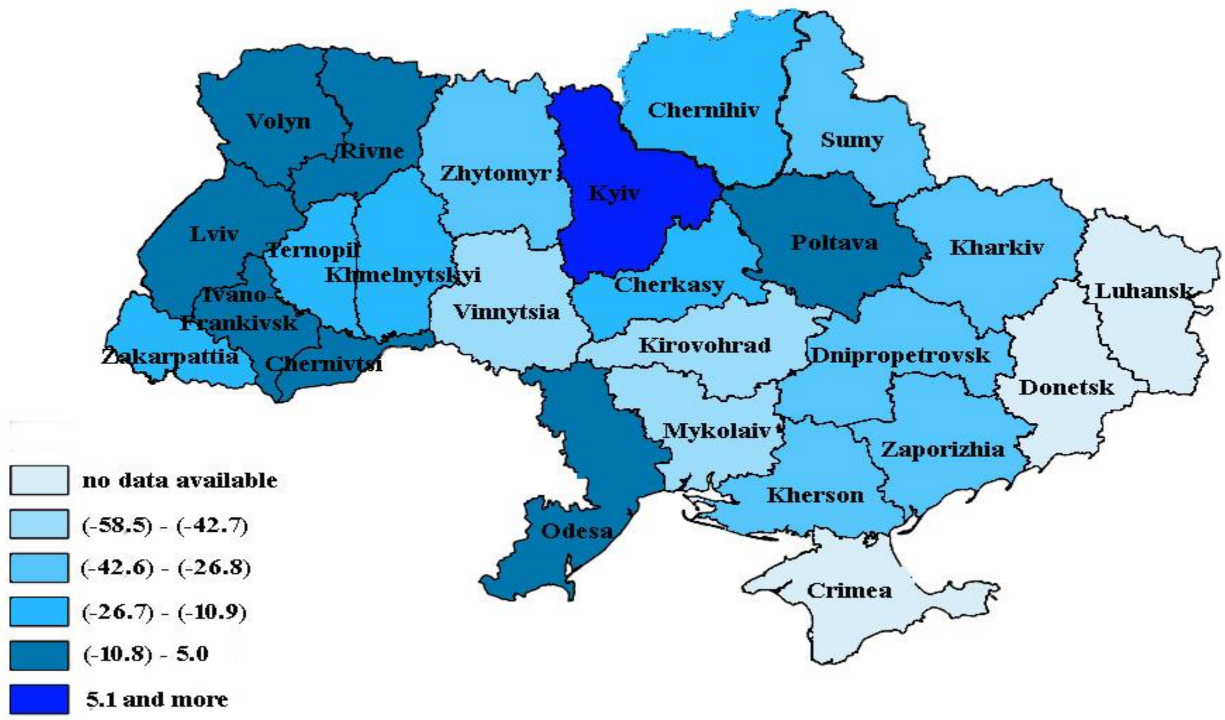

Fig. 1. Map of the results of grouping the regions of Ukraine by the total rate of migration growth, reduction (-) in rural areas in 2020, per 10,000 people of the existing rural population*
*Data on Luhansk, Donetsk regions, and the Autonomous Republic of Crimea are not available due to their temporary occupation by the Russian Federation and in accordance with the Law of Ukraine "On Temporarily Occupied Territories”.

As can be observed from the cartogram developed by us (Fig. 1), the largest negative migration increase among the rural population in 2020 is observed in Mykolayiv, Kirovohrad and Vinnytsia regions. The largest positive migration growth is characteristic of the Kyiv region, where the capital of Ukraine is located, as well as Odessa (a resort region with access to the sea) and most regions of the Western region, which are characterized by their agricultural orientation.

It is well known that globalization and integration are an objective reality today. At the same time, the national state policy in the field of rural employment should be pursued for the sake of social justice in the context of globalization. The crisis has shown that the results of the process of globalization and integration are beneficial only for a few countries, but are not fair to most of them, because the declaration of equal rights does not guarantee their observance, especially in times of economic downturn. Thus, it should be understood that Ukraine's membership in the European Union will not automatically transform the Ukrainian labour force from migrants to local residents. Various occupational standards, the supply of low-skilled jobs for migrants, language barriers, etc. are also serious risks to European integration for the rural workforce.

In addition, the problems associated with hypertrophied disparities in the demographic trends of the rural population pose a number of threats and negative consequences for the economic development of the regions and directly for the proper provision of socio-economic aspects of the functioning of rural areas. In general, this trend is pronounced in terms of the reduction of the economically active population in rural areas, which is associated with the outflow of labour to other industries or to other, more attractive regions in terms of development. All this entails an increase in social tension, a decrease in local budget revenues, along the need to ensure an adequate level of social security for the rural population [4].

At the same time, it can be argued that the trend towards a general decrease in the rural population is not surprising for European countries in general. In particular, population decline is currently characteristic of more than 30% of the countries of the European continent. Among European countries, Ukraine is also distinguished by the scale and protracted nature of depopulation of both rural and urban populations [21].

Characterizing the specific features of depopulation within Ukraine itself, we should first emphasize the higher intensity of natural population decline and the duration of depopulation trends in rural areas, where the excess of deaths over births has been observed for more than thirty years (since 1979).

According to the average version of the multivariate demographic forecast, developed by specialists of the Institute of Demography and Social Research of the National Academy of Sciences of Ukraine, with the probable overall reduction of the population of Ukraine by 2050. more than 18%, the number of its able-bodied contingent will decrease by more than 1/3 [18].

Migrations of the rural population also have a negative effect on the processes of demographic reproduction. After all, migrants are dominated by the most productive and economically productive age groups. Today, according to various estimates, from 5 to 8 million people are looking for work and work outside Ukraine, which, of course, does not contribute to the growth of the birth rate in Ukraine [16; 49; 53].

The birth rate and mortality of the rural population determine its natural movement. The birth rate is calculated according to the fertility rate, which is determined in relative terms as the ratio of the number of births per year to the average annual population.

$$Y = -26.4516 + 0.0539x_1 - 0.0278x_2 - 0.00315x_3. \qquad (7)$$

According to the results of the analysis of the correlation-regression model obtained by us, it is established that the first factor (X_1) has the most significant influence on the performance indicator. Namely, it was found that GDP growth by 1 thousand UAH per person causes an increase in the birth rate of the rural population in Ukraine by 0.0538 ‰. The least significant impact on the performance indicator in this model has the level of environmental pollution (X_3).

Table 2. Assessment of the representativeness and adequacy of the results of the formation of the correlation-regression model to identify the relationship between the relevant factors and the birth rate of the rural population of Ukraine in 2020

Factors	BETA coefficients	Standard error of BETA coefficients	Regression coefficient (B)	Standard error B	t- criterion	Actual materiality level (p-level)
X_1	0.26575	0.25109	0.05394	0.78372	1.74648	0.48768
X_2	-0.40483	0.25109	-0.02793	0.78372	-0.53241	-0.75322
X_3	-0.50263	0.25109	-0.00324	0.78372	-1.03294	0.08307

X_1 – GDP per capita, thousand UAH;
X_2 – level of rural unemployment, %;
X_3 – level of environmental pollution, thousand tons.
Source: own development.

Summarizing the results shown in Table 2, it should be noted that there is insufficient confirmation of the variation in the birth rate of the rural population in Ukraine under the influence of our selected factors. Thus, it can be argued that the relationship studied in the analysis of the various features is not really marked by a high level of reliability. At the same time, on the basis of the obtained results, it became possible to form specialized analytical cartograms (Fig. 2). Therefore, based on a comparison of the data presented on these maps, it is possible to reliably estimate the overall dynamics of the total birth rate in Ukraine (in rural areas) for the period 2016-2020.

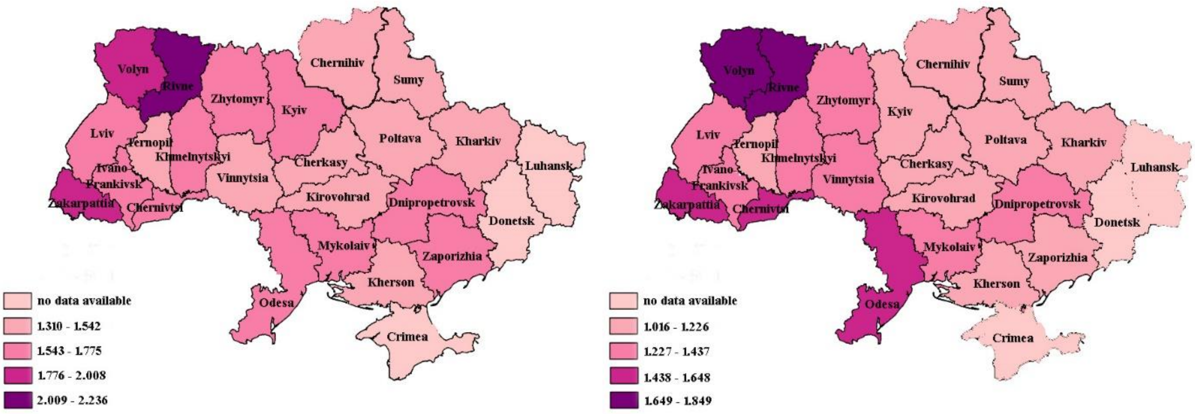

Fig. 2. Cartogram of the results of the grouping of regions of Ukraine by the total birth rate in rural areas in 2016 (left), and 2020 (right) per 1 woman*
*Data on Luhansk, Donetsk regions, and the Autonomous Republic of Crimea are not available due to their temporary occupation by the Russian Federation and in accordance with the Law of Ukraine "On Temporarily Occupied Territories".
Source: [48].

In particular, the dynamics of the formation of the total birth rate in rural areas for 2016 - 2020 revealed very positive dynamics of this indicator for the Volyn, Chernivtsi, and Odessa regions.
However, for the Zaporizhia region in the studied period, no positive dynamics were found. In addition, the Ternopil region of Ukraine is characterized by the almost unchanged indicator of the total fertility rate in rural areas in the study period, which indicates the questionable effectiveness of local government policy on the study.
The natural increase of rural population is one of the main in the system of socio-demographic indicators of economic

evaluation of rural areas of Ukraine in terms of sustainable development, so we conducted a study of its dependence on relevant macroeconomic and regional factors.

We have built a correlation-regression model to identify the relationship between the natural growth rate of the rural population of Ukraine and the three selected factors.

$$Y = 1.5537 + 0.00313x_1 - 0.00387x_2 - 0.00904x_3 \quad (8)$$

The results of the analysis of the influence of factor features on the natural movement of the rural population (formula 8), determined by the ratio of births and deaths per year to the average annual rural population, shows that the relationship between factor and performance is inverse (factors X_2; X_3) and cannot be considered significant. This suggests that the natural motion factors included in this model do not have a significant impact.

We found that among the selected factors the greatest inverse effect on the performance indicator is exerted by factor X_3, in particular, it was found that the increase in pollution by 1 thousand tons causes a decrease in the level of the natural movement of the rural population of Ukraine by 0.009‰.

Table 3. Assessment of the representativeness and adequacy of the results of the formation of the correlation-regression model to identify the relationship between the relevant factors and the natural growth rate of the rural population of Ukraine in 2020

Factors	BETA coefficients	Standard error of BETA coefficients	Regression coefficient (B)	Standard error B	t- criterion	Actual materiality level (p-level)
X_1	0.23731	0.23757	0.00322	0.00274	2.41362	0.04556
X_2	-0.04511	0.23757	-0.00366	0.00274	-0.63451	0.36215
X_3	-0.39588	0.23757	-0.00905	0.00274	-1.51513	0.04872

X_1 – GDP per capita, thousand UAH;
X_2 – level of rural unemployment, %;
X_3 – level of environmental pollution, thousand tons.
Source: own development.

Thus, the analytical study of the statistical population without cities of regional subordination of Ukraine (Table 3). allows us to conclude that we obtained a relatively homogeneous population, in which there is a small (23.73%), but confirmed impact on the performance of gross value added per capita (*p-level* = 0.04554) and 39.5 % impact of the level of environmental pollution (*p-level* = 0.04862).

Based on the results of the study, we built a cartogram that visualizes the results of grouping regions of Ukraine by natural increase, decrease (-) population in rural areas of Ukraine in 2020, per 1,000 people of the existing rural population (Fig. 3).

As can be seen from the cartogram (Fig. 3), the most negative value of natural growth (reduction) of the population in rural areas in 2020 is typical for Sumy, Chernivtsi, and Cherkasy regions, which, in our opinion, deserves special attention in the relevant public services. and local self-government organizations, whose activities are aimed at resolving the identified negative values and the formation of further positive trends in their development.

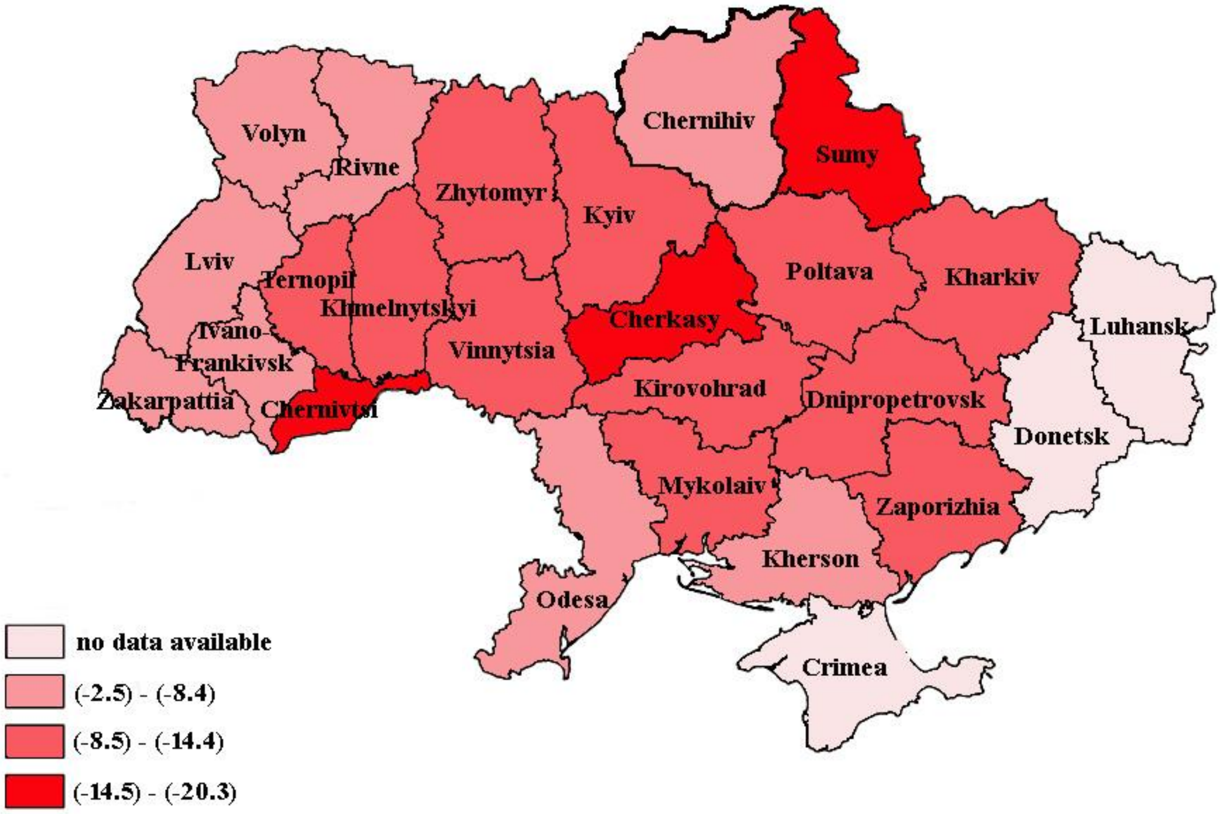

Fig. 3. Cartogram of the results of grouping the regions of Ukraine by natural increase, reduction (-) of the population in rural areas of Ukraine in 2020, per 1,000 people of the existing rural population*
*Data on Luhansk, Donetsk regions, and the Autonomous Republic of Crimea are not available due to their temporary occupation by the Russian Federation and in accordance with the Law of Ukraine "On Temporarily Occupied Territories".
Source: [48].

CONCLUSIONS

Thus, based on the study, it can be argued that there are objective problems associated with the socio-economic and demographic development of rural areas in Ukraine. The data obtained as a result of analytical calculations reflect the objective reality and indicate a negligible relationship between the selected for research economic, environmental, and socio-demographic indicators of socio-demographic development of rural areas. Given the fact that in real conditions the relationship between indicators is stochastic, finding the absolute truth in determining the relationship in practice is not always possible. But the approximate nature of any results of the correlation-regression analysis is not a reason to deny its usefulness and scientific purpose.
The results of our study provide an opportunity to confirm that in the context of Ukraine's official accession to the European Union and the serious challenges of today, the Ukrainian state should perform the functions of regulating the most important spheres of society in general. It can be argued that the priority for state institutions now should be economic incentives for rural development, attracting additional investment in agriculture and agritourism, and so on. The general trends of administrative reform and budget decentralization should also, above all, increase the level of investment in rural development, which will result in both an increase in the number of jobs and the provision of additional revenues to stimulate the socio-economic development of the village.
Thus, the achievement of high living standards of the rural population in Ukraine is possible only through the formation of appropriate mechanisms to stimulate economic and socio-demographic

development of rural areas by the state and public-private partnership.

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ENVIRONMENTAL MEASUREMENTS IN LAYING HENS HOUSES

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Abstract

Experiments were conducted in a farm in Mansoura during the period from June 2017 to October 2018, and the farm's capacity was 40,000 laying hens. The ideal environmental conditions needed for hens inside the closed houses such as air temperature, humidity, lighting for hours, air speed, to raise the higher rate of egg production and raise the rate of daily consumption of feed and reduce the mortality percentage, so measurements were used in the presence of ideal environmental factors and the absence of this ideal factors.The experiments aimed to determine the production capacity of the farm and the performance of laying hens, under measured and standard environmental conditions with the aim of increasing meat and egg production. Also, the environmental conditions were adjusted according to the ideal parameters to reduce the losses of feed and hen egg weight. The results revealed that the weekly growth in average weight of chickens approached the closest weekly increase of the standard weight of the herd breeding index to 244 g at the 24th week. Weight homogeneity increased from 83% to 92% at week 24. The difference of the mean weekly egg weight from the mean egg weight of the standard egg was the closest between them at the twenty-fourth week, and the difference between them was 1.6 grams. The mortality rate then decreased to 0.1% at the 24th week.

Key words**:** *poultry, environmental control, laying hens, egg, closed houses*

INTRODUCTION

The closed system in laying hens houses allows control of environmental factors such as humidity, temperature, number of hours of illumination and air speed have a direct impact on the percentage of eggs production, the rate of body weight increase, the rate of mortality and the spread of pathogens within the farm, so attention is needed to connect the climatic factors surrounding the bird to the standard level.
Over the last three decades, the poultry sector has grown at a rate of more than 5% per year and its proportion of global meat production has climbed from 15% three decades ago to 30% now. Local meat production was on average 1,454,856 tons during the period 2019, local egg production was 617,521 tons on average for the same period, according to (FAO, 2019) [8] .
DAFF (2011) suggested that Food production is a key 21st-century worldwide continuity challenge. The food and beverage industry accounts for 23% of world resource usage, 31% of acidifying emissions, and 18% of greenhouse gas emissions. Food consumption is expected to rise by 50% by 2050, and meat demand by 85%, according to the World Bank, due to the rising nations like China and India becoming wealthier and adopting Western-style eating habits heavy in meat and dairy products, where the productivity of Egypt in poultry meat recorded 1,454,856 ton in 2019 [4].
Linker et al. (2011) stated that the raising of domesticated birds, such as layers and broiler chicken in a small area is a big challenge. Poor management of the air conditioning systems could cause an excessive level of internal temperature and humidity, which could reduce poultry house productivity and result in severe consequences, such as lower feed conversion ratio, excessive energy consumption and accelerated mortality rate. Thus, new technologies, equipment, as well as new control methods, are still required to meet the target for the sustainable development of chicken production [15] .

David Farrell (2013) reviewed that Poultry meat and eggs are readily available, relatively affordable, and can play a critical role in meeting important nutritional deficiencies, particularly among the poor. [9].

Hosny (2006) suggest that Poultry production plays a major role in providing a large and cheap source of animal protein in Egypt. Eggs are the major business outputs in commercial table egg production and the higher egg production the better will be the profit. The layers usually start laying at about 20 weeks of age and peak of egg production is attained during the first production cycle (at about 32 weeks). The average production rate of commercial layers usually remains very close to 0.9 eggs per day. However, as the age increases, their egg production decreases. Egg production is a dependent variable and is influenced by several factors like strain, hen age, feeding, mortality, culling, health and management practices [13].

Scanes (2007) reported that he production of major poultry products (meat and eggs) has been quickly increasing across the world. This indicates consumption, which is based on customer demand for these high-quality items as well as the comparatively low price due to manufacturing efficiency. Between 1995 and 2005, consumption, and hence output, increased. The global percentage of chicken meat increased by (53%), duck meat by (67%), turkey meat by (13%), goose meat (53%), chicken eggs (39%) and other eggs (27%). The value added to chicken products, whether it is food processing and restaurants or alternative production techniques that attract higher pricing, is not taken into account in poultry production figures [16].

FAO (2013) pointed out that the chicken industry is one of the most rapidly developing and resilient of all animal industries. Because of the enormous demand for it, it has increased and spread across nations of all income levels during the last fifteen years. It accounts for around 80% of chicken stock in low-income food-deficit nations and contributes considerably to:

(1)producing income and modest savings, particularly for women, therefore increasing resilience to shocks and lowering economic vulnerability.

(2)supplying organic manure for vegetable gardens and agricultural production

(3)improving human nutrition by supplying high-quality nutrients and micronutrients in food (eggs and meat); and reducing food waste. Beyond its economic and nutritional value, the social, cultural, and religious aspects of village poultry farming have been generally acknowledged as important to smallholder livelihoods [7].

Gerber et al. (2013) showed that the global demand for chicken meat and chicken eggs is forecast to grow by 61%, and 39%, respectively, between 2005 and 2030. However, many studies have warned that increasing livestock production could cause environmental problems, particularly exacerbating global warming, also the global poultry supply chains contribute GHG emissions of 0.6 Gg CO^2-eq/year, representing eight percent of the livestock sector emissions [11].

Undesa (2015) found that the cumulative population growth is increasing at a much faster rate than food supply in all parts of the world. According to the United Nations, The main challenge facing the agricultural sector is not so much growing 70% more food in 40 years, but making 70% more food available on the plate [17].

Ekram et al. (2018) pointed out that the annual per capita share of chicken and poultry meat increased from approximately 8.6 kg/year in 2010 to about 12.83 kg/year in 2016, but poultry meat self-sufficiency fell from about 97.1 percent in 2010 to about 94.1 percent in 2013. Imports of chicken meat grew from around 24 thousand tonnes in 2009 to nearly 37 thousand tonnes in 2014 [1].

Dozier et al. (2001) Early in life, the chick is poorly equipped to regulate its metabolic processes to adequately control its body temperature. As a result, the young chick is dependent on environmental temperature to maintain optimal body temperature. Indoor air temperature is one of the most important environmental factors because, maintaining the correct air temperature is crucial in chicks

brooding, especially during the first 7 to 10 days of the chick's life. [5].
Lacy et al. (2003) stated that the furnaces produce warmth by producing heated air. This means that the floor must be warmed from hot air, which can require a long period since hot air rises, the forced-air furnace is more difficult to manage than pancake or radiant brooders for two primary reasons [14].
Czarick et al. (2005) mentioned that If litter moisture content exceeds 30%. this limit, ammonia was released. This means at higher moisture content leads to diffusion of ammonia [3].
Cobb Broilers Guide (2008) It is reported that, at placement floor temperatures should be at least 32°C with forced-air heating the heat source in heating the house with forced air furnace, it was found that a 10˚C, the difference between also floor and ceiling was problematic from a heating cost and chick performance [2].
Fairchild et al. (2012) confirmed that the temperature and relative humidity should be stabilized for at least 24 h prior to chick arrival. litter cackling can occur during the first week brooding should be at 34 ºC floor temperature and to decrease about 3 ºC every week until the cycle end reaching 24 ºC. If the air relative humidity is below 50%, litter would be too much dry, and if air relative humidity is above 70% [6].
Ghoname and Fouda (2015) mentioned that the indoor air temperatures decreased as the broiler age increased throughout the living cycle, during the first stage of brooding, the recommended floor temperature was 34°C at the first day of chick's life and reduced gradually until reached 30°C at the end of brooding stage [12].
Fouda and Kassab (2020) mentioned that during these last decades, the production of poultry meat increased from 54 to 112 million tons, its share in total meat production. Incubators need to maximize chick production, and this entails not only the incubation of more fertile eggs [10].
A lot of problems facing laying hens affect the health of laying hens and the high level of ammonia and the spread of pathogenic agents inside the houses, reflecting that the environmental factors do not meet the standard level at which laying hens produce their highest level of production.
The main objectives of this study were to e evaluate the effect of variation between environmental measurements and ideal parameters in closed system of laying hens housing.

MATERIALS AND METHODS

Experiment was carried out through 2019/2020 in Gamasa, Dakahlia Governorate, Egypt. The capacity of the farm was 40,000 laying hens.
A sample of 500 chicken was used, and its characteristics are given in Table (1).
The sample is characterized by the presence of two reproductive periods, the first of which is 24 weeks of age for chickens, called the breeding period, and the second has a period of 40 weeks, which is the period of production.

Table 1. Cobb characteristics

Breeder	Performance
Age at depletion	65 weeks
Age at 5% production	24 weeks
Total eggs / hen housed	181.3 %
Hatching eggs / hen housed	176.3 %
Peak hatchability	90 %
Cumulative hatchability	85.6 %
Broiler chicks / hen housed	150.9 %
Livability from 24 weeks	92.3 %

Source: Cobb Broiler management guide, www.Cobb.com.

Work was carried out in farm with a closed system for the production of eggs. consists of 6 floors, each floor has two houses without side dimensions (25 m wide x 150 m), the dimensions of the house (55 m x 12.5 m x 3 m) with a nominal capacity of 4,000 chickens in the production period, the house system is dark for breeding. The drinking system was used on three per line, containing 17 pieces, the length of the piece is 3 meters, and each piece has 12 nipples, one of which is sufficient for 10 birds. The heating system on an air-driven heater. A ventilation system with a circulating air for 44,000 m^3/h was used, and the feeding system is a closed floor chain feeding system.

A mathematical equations was used to calculate the production capacity of the farm, the amount of feed for poultry, egg productivity and the mass of the resulting eggs, which are:

-Hen-Day Egg Production (HDEP)

$$HDEP = \frac{\text{Total number of eggs produced during the period}}{\text{Total number of hen} - \text{days in the same period}} * 100$$

-Feed efficiency (Feed conversion ratio – FCR)

$$\text{FCR (per kg egg mass)} = \frac{\text{Kg of feed consumed}}{\text{Kg of egg produced}}$$

-Feed efficiency per dozen eggs

$$\textbf{FCR (per dozen eggs)} = \frac{\textbf{Kg of feed consumed}}{\textbf{Total eggs produced}} * \textbf{12}$$

-Net Feed Efficiency Index (NFEI) is calculated using egg production, egg weight, feed consumption, and body weight increase

$$NFEL = \frac{(EM + BW) * 100}{FC_S}$$

where:

EM = Mean egg mass in g during a specific period.

BW = Mean body weight gain or loss in g during a particular period.

FC = Mean Feed consumption/hen in g during a particular period.

RESULTS AND DISCUSSIONS

The laying body weight and age

Figure 1 depicts the connections between the average weight of the bird in grams and the age of the laying hens every week for the duration of the research period, and it was discovered that the average body weight is directly related to the age of the bird. The average body weight of the bird has progressively risen with age, from 145 g in the first week to 4,624 g at the conclusion of the cycle. The typical bird's average weight grew from 145 g in the first week to 4,260 g at the conclusion of the cycle.

A linear relationship was obtained between the laying body weight and age as presented below.

Actual: $y = 74.364x + 761.07 \quad R^2 = 0.8635$

Target: $y = 66.218x + 812.23 \quad R^2 = 0.8628$

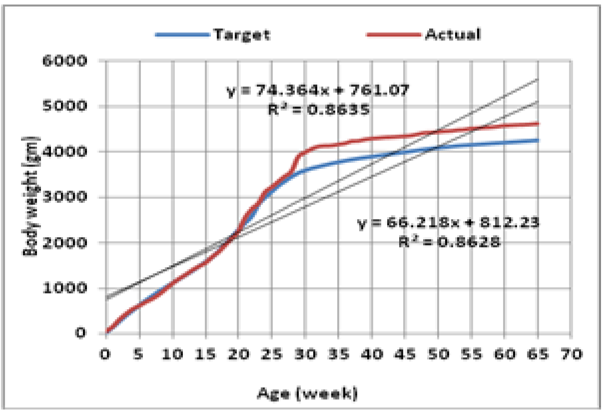

Fig. 1. Body weight of laying hens with age per week.
Source: Authors' determination.

The age of the bird and the amount of mass gained weight

Figure 2 depicts the relationship between the age of laying hens every week and the mass gained in grams throughout the research period. It was discovered that during the breeding period the mass gained increases at a rate greater than the production period, as it gains 99 grams in the first week, while it only gains 13 grams at the end of the cycle, and the largest mass gained in the twenty-ninth week is 318 grams.

A linear relationship was obtained between the age of the bird and the amount of mass gained weight.

$y = -2.4315x + 150.67 \qquad R^2 = 0.4237$

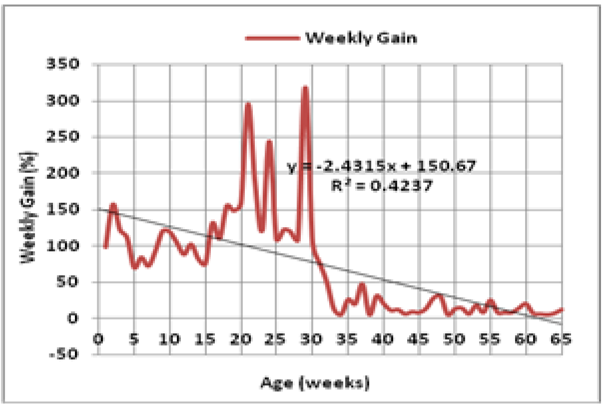

Fig. 2. Weekly gain weight with age per week.
Source: Authors' determination.

Bird age and uniformity ratio

Figure 3 depicts the relationship between the age of laying hens each week and the percentage of weight uniformity throughout the research period. the range of optimal weight uniformity is between 90 % and 110 %. it was discovered that during the breeding period, the percentage of weight uniformity is 83% in the first week, while the percentage of uniformity is in the twenty-fifth week, it reached 92%, and the highest percentage of uniformity reached by the farm was 97%.

A linear relationship was obtained between bird age and uniformity ratio:

$y = 0.1823x + 90.71$ $R^2 = 0.1422$

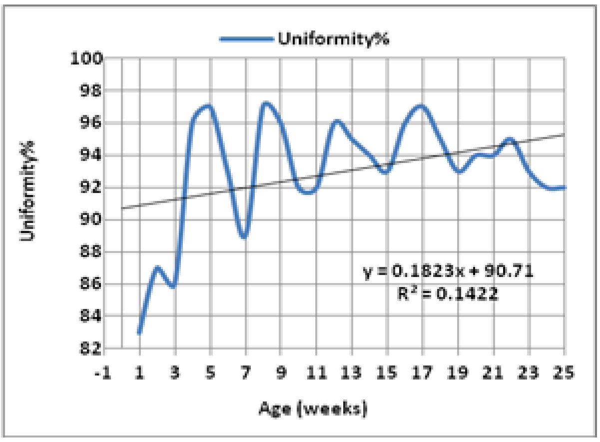

Fig. 3. Body weight of laying hens with age per week.
Source: Authors' determination.

Feeding laying hens

Figure 4 depicts the average amount of feed provided to laying hens weekly and calculated in grams.

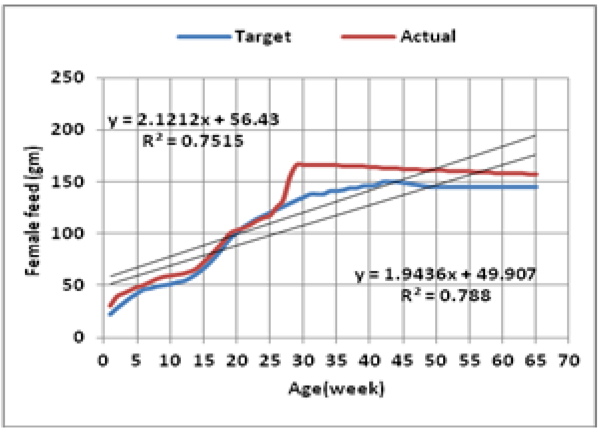

Fig. 4. Female feed per (gm) with age per week.
Source: Authors' determination.

It was noticed that the standard quantity in the first week begins with 22 gm in Figure 5 and increases to 145 gm at the end of the cycle, whereas the actual average amount of feed provided to each bird begins with 30 gm and increases to 157 gm at the end of the cycle.

A linear relationship was obtained between depicts the average amount of feed provided to laying hens weekly.

Actual: $y = 2.1212x + 56.43$ $R^2 = 0.7515$

Target: $y = 1.9436x + 49.907$ $R^2 = 0.788$

Poultry mortality rate

Figure 5 depicts that the experiment began with a total of 26,250 chicks, however due to the birds' inability to adjust to their surroundings or weather variables, a tiny number of birds perished, resulting in a total of 24,093 birds in Figure 6 at the end of the period. Whereas the death rate in the first week began at 0.4 percent and decreased to 0.1 percent at the conclusion of the period, the cumulative mortality rate reached 8.6 percent at the end of the cycle. A linear relationship was obtained for poultry mortality rate

$y = -28.709x + 25809$ $R^2 = 0.9423$

$y = 0.1127x + 1.7778$ $R^2 = 0.9518$

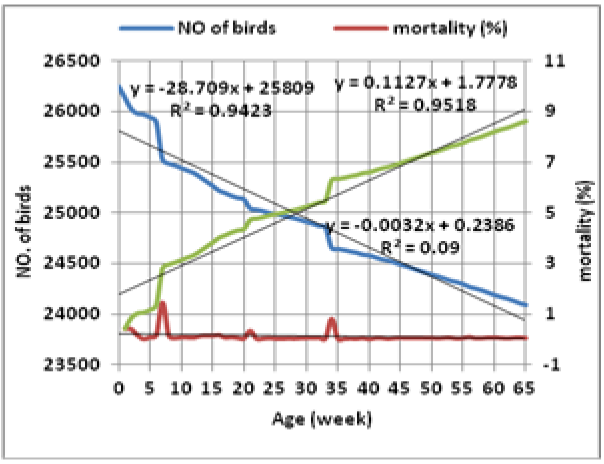

Fig. 5. Number of birds with age per week.
Source: Authors' determination.

Laying hens production

Figure 6 depicts the egg production rate in laying hens and the number of eggs per week were determined after 24 weeks, and because the percentage of egg production began at 1%, the number of eggs in the 24th week was 250 eggs. While the greatest rate of production was 87.1 percent at week 30, with a value of

21,699 eggs, egg production dropped until it reached 42.1 percent at week 65, with a value of 10,143 eggs. A linear relationship was obtained for the egg production rate in laying hens and the number of eggs per week

$y = -0.5254x + 85.823$ $R^2 = 0.125$

$y = -141.11x + 21609$ $R^2 = 0.143$

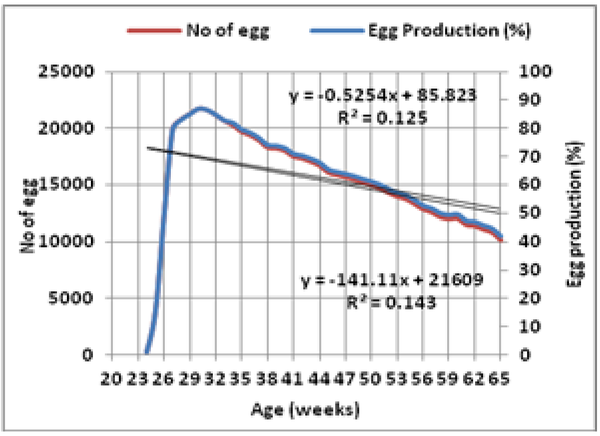

Fig. 6. Weekly Number of Eggs and egg Production.
Source: Authors' determination.

Egg weight of a laying hen

Figure 7 depicts the weight of chicken eggs was calculated on a weekly basis. At week 24, the egg weight was 50.1 g, which was higher than the normal figure of around 48.50 g. While the egg's maximum weight was 73.5 gm in the 65th week. This number was also higher than the normal value of about 71.1 gm. A linear relationship was obtained for the weight of chicken eggs.

$y = 0.4769x + 42.872$ $R^2 = 0.8892$

$y = 0.4549x + 47.014$ $R^2 = 0.8482$

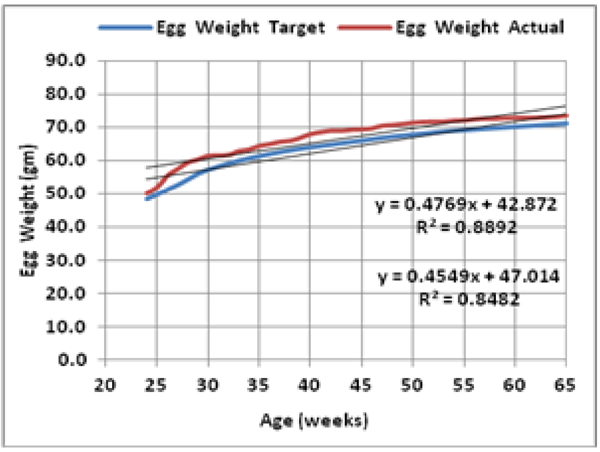

Fig. 7. Weekly weight of Eggs and age
Source: Authors' determination.

CONCLUSIONS

The main objectives of this study to reach of optimum environmental inside laying hens houses to avoided a higher production rate. The weekly increase in average weight of chickens approached the closest weekly increase of the standard weight of the herd breeding index to 244 g at the 24th week. Weight homogeneity increased from 83% to 92% at week 24. The difference of the mean weekly egg weight from the mean egg weight of the standard egg was the closest between them at the twenty-fourth week, and the difference between them was 1.6 grams. The mortality rate then decreased to 0.1% at the 24th week.

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MONITORING CHANGES IN COWPEA COLOR AND STORAGE CONDITIONS

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Abstract

The optimum and safe storage treatment for cowpea and evaluate changes in quality during storage in different types of hermetic bags. Using two different pre-conditioning methods infrared heating and ultraviolet radiation compared with Non-treated on cowpea seeds before storage process. The aim of this study to discrimination of color change for Cowpea seeds were treated by FIR and ultraviolet UVC irradiation intensity, the seeds was stored in woven and hermetic bags (three & seven layers), the differences in Red color band increased from 161.3 to 197 when using the seeds that irradiated with FIR radiation and stored in 3 and 7Layers bag,, while at woven bag increased to 247.6 the differences in intensity I_2 increased by using UVC radiation and stored in woven bag and the differences in R/G increased by 9.5% when using in the seeds that irradiated with FIR radiation and stored in three layers bag. the differences in Hue increased by 7.14% when using the seeds that irradiated with UVC and stored in three layers bag, The moisture content of seeds stored in woven bags increased to 14.82% in contrast with both types of hermetic bags which approached to 10.8% and 10.7% of three layers and seven layers bags respectively due to moisture absorption from surrounding air and also the released moisture due to high respiration rate of seeds and microorganisms. Seven-layer bags recorded the highest levels of Carbon dioxide concentration inside the bags which arrived at the end of storage period to 24.8%, 20.9 % and 20.5% for non- irradiated, infrared irradiated and ultraviolet irradiated bags respectively. Carbon dioxide inside the three-layer bags were to 19.7%, 16.9 % and 16.2% for the non -irradiated, infrared irradiated and ultraviolet irradiated treatments in respectively.

Key words: *Cowpea, color, radiation, UVC, FIR , storage, hermetic bags*

INTRODUCTION

Cowpea is a nutritionally food in the human diet. Cowpea has a high protein and carbohydrate content, a low fat, and integral amino acid pattern to cereal grains, Rebello et al. (2014) showed that the legume seeds nutritional benefit, also known as pulses, resides in their nutritional value, including large quantities of carbohydrates (30% to 40%), proteins (from 17% to 40%), dietary fibre (from 8% to 27.5%), fat (from 5% to 47%), and with sufficient quantities of essential amino acids like leucine, arginine, and lysine [20]. Elhardallou, et al. (2015) mentioned that a lack of sulphur-having amino acids slows of digestibility, and anti-nutritional factors like trypsin inhibitors, phenolic compounds and oligosaccharides, are all major limiting factors for cowpea consumption in a typical diet [6]. However, proper methods of processing could be used to reduce antinutritive factors and increase bioavailability, particularly at consuming. Jayathilake et al. (2019) reported that Cowpea protein source is a high-quality plant that is commonly consumed [14]. Cowpea is a nutritionally food in the human diet. Cowpea has recently sparked widespread interest among consumers and researchers due to its health-promoting properties, which contain anti-cancer, antihypertensive, anti-hyperlipidemia, anti-inflammatory, and anti-diabetic properties.

Cowpea are more difficult to store than cereals and they suffer much greater damage from insects and microorganisms. This not only results in quantitative losses, but also in qualitative reduction of the nutritive value because of vitamin loss and deterioration of protein quality. The losses due to insect-damaged grain are even higher as more breakage and powdering occur with such grain. Mason et al. (2012) found that for stored grain insects, the most favorable grain moisture content level is 12 to 18 percent [18]. In certain cases, insect infestation exacerbates mold problems in grain by exposing mold-prone endosperm surfaces, transferring mold spores to new locations, and promoting mold germination in microhabitats rendered moist by insect metabolic activity. Suleiman and kurt (2015) [23] told that molds and fungi that develop in grains and seeds during storage and transportation cause germination, discoloration, musty or sour odors, caking, nutritional and chemical changes, the formation of mycotoxins and manufacturing quality reduction.

The application of infrared heating FIR of cowpeas revealed an improvement in the cooking characteristics, increasing the water uptake of seeds during soaking and improving in the sensory qualities of seeds such as appearance, flavor and texture. Infra-red heating also reduces moisture content of seeds and used as sterilization process to seeds before storage. On the other hand, Ultraviolet radiation (UVC) is non-thermal method (physical method) mainly used for microbial disinfection. Exposure of microorganisms to UVC light affecting the DNA. Mwangwela et al. (2007) [19]. reported that Pinto beans, black beans, green peas, kidney beans, cow peas, lentils, and soy beans were analyzed to see how infrared treatments affected their properties. The legumes were heated to 140°C on the surface, they found that valuable changes in the seeds' physical characteristics the function of the trypsin inhibitor was decreased. The starch and protein content of the seeds were not affected by infrared heating. Krishnamurthy et al. (2010)[16]. reported that far-infrared radiation can be used for the heating of food systems and inactivation of pathogens because of higher absorption of energy in the far-infrared wavelength range (3 to 1,000 μm) by microorganism and food components. Therefore, infrared heating has the potential to inactivate microorganisms in foods. The food substances absorb FIR energy most efficiently through the mechanism of changes in the molecular vibrational state, which can lead to radiative heating. The main components of food, absorb FIR energy at wavelengths greater than 2.5 μm. Sun (2012) [24]. mentioned that there are two types of natural water molecule vibrations: vibration of symmetrical deformation and vibration of symmetrical stretching. The body absorbs infrared energy that is related to certain frequencies effectively. As a result of the change in the state of vibration of the vibration process, the food absorbs infrared radiation efficiently at wavelengths greater than 2.5 μm, causing its temperature to increase (heating).

UV light is used in a variety of applications in the food industry. High-performance UV light sources and equipment can clean, wash, and process water, air, and surfaces. In a cost-effective and environmentally friendly way, the chemicals used may be reduced or even removed. Souza et al. (2004) [22] The wavelength of UV-light is divided into three bands—UV-A, UV-B, and UV-C, the long (UV-A, 400–320 nm) and middle (UV-B, 320–280 nm) wavelengths are present in sunlight and have some germicidal value. However, the short wavelengths or UV-C (280–100 nm) has high germicidal capacity and do not naturally exist, having to be produced by the conversion of electric energy. Howarth (2007) [13] noted that ultraviolet light as a nonchemical disinfection process is gaining popularity due to its germicidal properties. The ultraviolet method's equipment has a low operating cost, apart from being an eco-friendly technology that reduces the need for many chemical treatments, it is also capable of providing high standards of protection. Koutchma (2019) [15] described that ultraviolet-C treatment is a nonthermal procedure that has been licensed for use as a disinfectant for the surface treatment of food products. Ultraviolet-C treatment leaves no trace in the treated products. Unlike the majority of organic disinfectants, ultraviolet-C radiation deactivates pathogen microorganisms by transmitting energy of electromagnetic from a transmitter, such as a germicidal lamp (λ = 253.7 nm), to the nucleic acids of the microorganisms by a photochemical reaction. Fouda, et. al (2021) [8] study effect of infra-red and ultraviolet radiation on sterilization and trypsin inhibitor deactivation of cowpea seeds the results showed that, for infra-red pre-treatment the irradiation intensity of 882.67 w/m2 at exposure time of 15 min. Is recommended. At this level of radiation intensity and exposure time, the total microbial count was 2.3 log cfu/g., protein content 28.88 %, trypsin inhibitor 1.148 tiu/mg and moisture content 8.13 % w.b. Meanwhile, for the uvc pre-treatment, irradiation intensity of 3.538 mw/cm2 and exposure time of 40 mins is recommended to get total microbial count of 2 log cfu/g., protein content 28.15%, trypsin inhibitor 0.57 tiu/mg and moisture content 10.95%.

Also considering the period of shelf life of seed and different types of barriers films. Aboagye et al. (2017) [3] studied the parameters evaluated were the moisture content, insect infestation, usable proportion, and 1,000 grain mass in both hermetic and non-hermetic systems. Also the effect of hermetic and non-hermetic storage on cowpea in plastic containers in the tropics area. The cowpeas were stored in hermetic and non-hermetic containers over a period of 12 weeks. The results showed that the number of live insects drastically reduced to zero in the hermetic system from the fourth week to the twelfth week,. The moisture content in the hermetic containers increased slightly from 11.7 to 11.9% compared to a sharp increase from 11.7 to 17.2% in the non-hermetic plastic containers. Also, the mass of 1,000 grains reduced from 156.50 g on week zero to 145.21 g in the non-hermetically stored grains, while the hermetically stored grains recorded a decrease to 148.95 g. In the case of the non-hermetic containers, the population of live insects/100 g of grains increased from 5 on week 0–71 on the twelfth week. Finally, the usable proportion of grains in the hermetic system declined from 98.55 to 94.80% after 12 weeks of storage as compared to the drop to 85.69% seen in the non-hermetic system.

Silva et al. (2018) [21] the use of modified atmosphere through hermetic storage in polyethylene silo bags and polyethylene terephthalate (PET) bottles as a technique to preserve the quality of cowpeas during storage. Cowpea grains were stored in polyethylene silo bags, polyethylene terephthalate (PET) bottles and glass recipients (control) for 30, 60, 90 and 120 days. The moisture content, bulk density, germination percentage and electrical conductivity of the cowpeas were preserved in both hermetic storage systems that were tested for 120 days.

CIE. (1989) [5] designated specific wavelengths to the primary colors: Red 700 nm, Green 546.1 nm, and Blue 435.8 nm. The color analysis of the seeds was based on an RGB histogram of pixel values tested. RGB representation is important in digital image processing due to its wide use in digital imaging hardware, such as color cameras and monitors. Lebert (1992) [17] Color of the packaged product, though, is the first quality parameter that the consumer perceives. Also Sensory properties of the legumes, such as, aroma, flavor, texture, and color are significant. The color is the most important parameter describing the quality of beans. This is in agreement with various large-scale consumer studies in which 40–60% of grade points, related to quality, were assigned to color.

Francis (1994) [10] showed that the color of beans is changing during storage, affecting the desirability of the product by the consumers. Colorimetric techniques have been used to determine the reaction kinetics constants for the discoloration of vegetables. Color deterioration of foods, occurring during storage is due to either an enzymatic action or a chemical reaction. Non-enzymatic browning is due to either oxidative browning or non-oxidative browning in the absence of oxygen, as a result of chemical reactions between proteins and reducing sugars.The enzymatic browning usually occurs in cases where enzymes are activated, often after a cut of the product, and results in very rapid change of the color. Considering the typical shelf life of beans (1–2 years), the mechanism of color deterioration during storage is probably due to both enzymatic and chemical browning.

Francis (1995) [11] mentioned that appearance is one of the major factors the consumer uses to evaluate the quality of food products. The appearance of a product as judged by its colour can often be used to determine the pigment content of a product, which in turn is often an index of quality.

Berrios, Swanson and Cheongh (1998) [4] thought that complex reactions are activated inside the grains, involving different cell components such as cell wall polymers, phenolics, starch, protein and enzymes, initiating the hardening and/or darkening phenomena.

Gonzalez and Woods (2002) [12] showed that Color is considered a fundamental physical property of agricultural products and foods. Human perception of color is a function of the response of three types of colors, that are blue, green and red.. The eyes interpret the incoming light into three colors and finally the three colors are received by the brain and re-interpreted as the complete spectrum in the form of a color circle. There are common indicators used to recognize ripeness of the agricultural products and thus determine the best time to harvest the products. Unay and Gosselin (2002) [25]. stated that a co-occurrence matrix is a square matrix whose elements correspond to the relative frequency of occurrence p (i, j) of two-pixel values (one with intensity i and the other with intensity j), separated by a certain distance d in a given direction.

Fouda,T. and Salah, S (2014) [7] showed the relationships between hue and saturation and total soluble solid acidity and percentage of liquid. The multiple regression analysis and correlation coefficient was used to test the association between some chemical properties different hue and saturation to ranked the more suitable maturity indices. The results obtained in this research demonstrated that hue and saturation indices gives understanding about between total soluble solid, acidity and percentage of liquid. The coefficient of determination at all properties equation of saturation indices more than with hue indices. Fouda and Albebany (2021) [9]. Color can distinguish between different varieties of wheat imported from different countries. It is also possible to distinguish between Ergot fungi sclerotia and between different types of imported wheat, and the color indicators used showed a clear contrast between wheat and Ergot fungi sclerotia, for example. The physical specifications also showed the differences that distinguish between mushrooms and wheat, which can be used to design the sieve holes for the specific separation.

The main objectives of this study to evaluate the changes in cowpea quality during storage of pre-treated cowpea in different types of hermetic bags, store cowpeas as long as possible without biological infestation, determine the appropriate bag for storage, Also determine the relations shapes between color and protein content, trypsin enzyme inhibitor, and total microbial count and determine the safe limits for the use of ultraviolet and infrared radiations with cowpea seeds.

MATERIALS AND METHODS

Materials

Before storage Cowpea in different types of barriers films were treated with by different pre-treatment methods of infrared and Ultraviolet for sterilization and deactivation of trypsin inhibitor

Cowpea seeds

The cowpea seeds var. (Dokki 126) were used for this experiment. The tested samples were obtained from EL Aiatt, Giza Governorate, Egypt.

The infrared heating unit was used as thermal treatment for the experimental work . A rotary cylinder made of 1 mm galvanised iron sheet (0.6m diameter and 0.2m long) is enclosed by a fixed insulated cylinder (0.8m diameter and 0.3long).

Ultraviolet radiation unit

Cowpea was conducted using a prototype irradiator consisting of two UVC lamps (4136 G36T6-20W - 254 nm), the length of the lamp is 60cm. The unit body was made of metal sheet plated with electrostatic substances (820 mm length and 520mm width), the inside surface of the unit is made of stainless steel 304 with a door made of poly carbonate for protection from uv-c radiation.

Hermetic bags

Two different types of barriers films were used for the experimental work. The materials specifications of the barrier films were assessed in the laboratory of Shuman company.

Methodology

The pre-condition process was done, and the optimum treatment for both pre-conditioning methods (Infra-red and ultraviolet) in terms of reduction moisture content, preserving protein content, deactivate trypsin inhibitor, and reduction of total microbial account were chosen for safe storage process the statement of experiments showed in Fig. 1. The produced bags were filled by the non-heat-treated cowpea at initial moisture content of (10.95%) w.b% and pre-treated cowpea seeds with the most proper intensity and exposure time for both examined pre-conditioning methods as follows:

-For infrared conditioning treatment, the radiation intensity of 882.67W/m^2 and an exposure time of 15 min was selected for storage process.

-For ultraviolet conditioning treatment, the radiation intensity of 3.538 mW/cm^2 and an exposure time of 40 min was selected for storage process.

-The storage experimental was conducted under the following steps:

1-Fill cowpea in different types of examined bags at capacity of 20 Kg/bag and close the bags previously using the heat-sealing apparatus.

2-Store the bags in a proper storage room in the three groups (three layers- seven layers- woven bags). Each group contain 9 bags with capacity 20Kg/ bag.

Take monthly measurements of carbon dioxide, oxygen gas, temperature and relative humidity inside the stored bags of each group.

Take samples from each experimental bag for quality evaluation tests including moisture content measurements, protein, total microbial count.

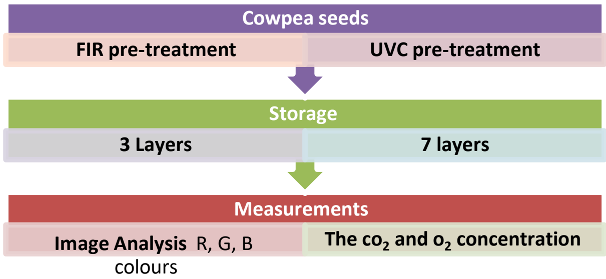

Fig. 1. The experiments statement
Source: Authors' drawing.

Measurements

-The CO_2 and O_2 concentration was monitored in every month using co_2 and o_2 sensor (VI GAZ "Gas analysis- model Box 121, (VI GAZ Company, France).

-Moisture content was determined by the standard oven method. Samples were taken before and during the drying and weighted oven dried to constant mass at 105°C for 24 hours (AOAC, 1990) [1].

-Monitoring CO2 and O22 concentration

The CO2 and O2 concentration was monitored in every month using CO2 and O2 sensor (VI GAZ "Gas analysis- model Box 121, (VI GAZ Company, France).

-Total microbial count

Total microbial count activity was determined following the methodology about 25 g from the samples was transferred in to a stomacher bag (Seward, London, UK), and homogenized with 225 ml of sterile saline peptone water (SPW: 1g/1 peptone, 8.5g/l sodium chloride) for 3 min .

-Insect detection (insect/kg)

The cowpea seeds were sieved and the weevils were identified according to (AOAC, 2000) [2].

-Color Analyzer Model: RGB-1002 were used.

The RGB-1002 is a portable color analyzer equipped with an external sensor probe having a 45°/0° color measuring geometry. The modem, accurate microprocessor technology uses the spectral analysis method to determine the color of the sample. Excellent repeatability due to the use of spectroscopic analysis technique. To get the color value (R, G, B or H, S, I).

RESULTS AND DISCUSSIONS

Storage performance

The moisture content, Oxygen and Carbon dioxide concentration, Total microbial count and seed color indices affected by storability time and using infra-red (IR) and ultraviolet (UVC) intensity as a pre-conditioning process of cowpea seeds

The moisture content

The effect of different irradiation and Type of bag during storage period on moisture content of seeds is shown in Table 1. The initial cowpea moisture content was 10.95 % w.b and the final cowpea moisture contents woven .bag were (14.82, 10.82 and 9.1 % w.b) at not – irradiated, ultraviolet radiation and Infra-red radiation respectively. While when used 3-layer bag the final cowpea moisture contents Woven. bag was (10.80, 10.60 and 8.28 % w.b) at not – irradiated, ultraviolet radiation and Infra-red radiation respectively. Also, when used 7-layer bag the final cowpea moisture contents woven bag were (10.70, 10.55 and 8.20 % w.b) at not – irradiated, ultraviolet radiation and Infra-red radiation respectively.

Table 1. Seeds moisture content inside the bags with and with out radiation

Treatment	Storage	Type of bag		
	period day	Woven. Bag	3-layer bag	7-layer bag
not – irradiated	1	10.95	10.95	10.95
	240	14.82	10.8	10.7
ultraviolet radiation.	1	10.73	10.89	10.82
	240	10.82	10.6	10.55
Infra-red radiation	1	8.13	8.13	8.13
	240	9.1	8.28	8.2

Source: Authors' determination.

Oxygen concentration

The effect of different irradiation and Type of bag during storage period on Oxygen concentration is shown in Table 2. The initial Oxygen concentration was 19.80 % and the final Oxygen concentration in Woven. bag were appear little changes at not – irradiated , ultraviolet radiation and Infra-red radiation respectively. While An obvious change occurred when used 3 and 7 layer bag Oxygen concentration of woven bags were closed to the atmospheric levels.

Table 2. Oxygen concentration % inside the bags with and without radiation

Treatment	Storage	Type of bag		
	period day	Woven. bag	3-layer bag	7-layer bag
not – irradiated	1	19.9	12.5	8.9
	240	19.2	6.7	5.5
ultraviolet radiation.	1	19.60	17.90	17.30
	240	19.30	8.40	8.10
Infra-red radiation	1	19.5	17.5	17.1
	240	19.3	7.5	7.3

Source: Authors' determination.

Carbon dioxide concentration

The effect of different irradiation and Type of bag during storage period on Carbon dioxide concentration is shown in Table 3. The initial Carbon dioxide concentration 0.1 and the final Carbon dioxide concentration in Woven. bag were appear little changes at not – irradiated, ultraviolet radiation and Infra-red radiation respectively. While An obvious change occurred when used 3 and 7 layer bag

Table 3. Carbon dioxide concentration inside different types of bags with and with out radiation

Treatment	Storage	Type of bag		
	period day	Woven. bag	3-layer bag	7-layer bag
not – irradiated	1	0.1	3.9	4.5
	240	0.7	19.7	24.8
ultraviolet radiation.	0.1	3.1	3.5	0.1
	0.7	16.2	20.5	0.7
Infra-red radiation	1	0.1	3.5	4.3
	240	0.6	16.9	20.9

Source: Authors' determination.

For both studied types of hermetic storage bag the average oxygen concentration decreased and carbon dioxide increased to levels prevents growth of microorganisms and insects depends upon seeds condition and the pretreatment method. The average levels of O2 ranged from 19.8% to 5.5% and the level CO2 ranged from 0.1% to 24.8%.

Total microbial count

The effect of different irradiation and Type of bag during storage period on total microbial count of cowpea seeds. As shown in the Table 4, the total microbial count (TMC) reduced from 4.6 to 3.1 (Log10 CFU/g) at not – irradiated with 3-layer bag and reduced from 4.5 to 2.8 (Log10 CFU/g) at not – irradiated with 7-layer bag. While at ultraviolet radiation management reduced from 2.00 to 1.70 (Log10 CFU/g) with 7-layer bag and reduced from 2.1 to 2.1 (Log10 CFU/g) at Infra-red radiation with 7-layer bag. Continuous increase in microorganisms' infection was detected for the seeds stored in pp woven bags under the three conditions of seeds (not irradiated, FIR irradiated and UVC irradiated). Whereas the rate of seeds infection was lower for the seed stored in both types of hermetic bags. Hermetic storage bags that filled with the irradiated seeds ultraviolet or infra-red heating process showed no insects at the end of storage period however the woven bags contained live populations of cowpea weevil insect (*Callosobruchus maculatus*) recorded 81 insect/kg for the non-treated seeds, 13 insect/kg for irradiated seeds with IR and 11 insect/kg for the heat-treated seeds with UV.

Table 4. Total microbial count inside different types of bags with and without radiation

Treatment	Storage period day	Type of bag Woven. bag	3-layer bag	7-layer bag
not – irradiated	1	5	4.6	4.5
	240	5.68	3.1	2.8
ultraviolet radiation.	1	2.2	1.9	2
	240	3.8	1.9	1.7
Infra-red radiation	1	2.5	2.1	2.2
	240	3.7	2.1	2.1

Source: Authors' determination.

Optical properties of cowpea seeds

The results show high variances in color indices for cowpea stored with different types of hermetic bags were treated with infrared and ultraviolet radiation showing in Figure 2 to 7 Color indices RGB color, Red/ Green ratio, his color intensity I_1, I_2 and color saturation Hue were tested as color properties for cowpea during storage period with different bag types. The highest and lowest value of Red band ranged from 254 to 123 were observed in the seeds that irradiated with UVC and stored in woven bag and the seeds that non irradiated and stored in three layers bag as shown in Figure 2, while the highest and lowest value of green band ranged from 183.3 to 88.6 as shown in Figure 3 and 4 for blue band for the seeds that irradiated with infrared and stored in woven bag and the seeds that non irradiated and stored in three layers bag as shown in Figure 4.

Figure 4 illustrates the relationship between hue and two different pre-treatment methods of infrared (thermal method) – ultraviolet (irradiation method) using different types of hermetic bags. The highest and lowest value of Hue ranged from 0.56 to 0.42 were observed in the seeds that irradiated with UVC and stored in three layers bag and the seeds that irradiated with infrared and stored in three layers bag. Figure 5 and 6 show the relationship between intensity and two different pre-treatment methods of infrared (thermal method) – ultraviolet (irradiation method) using different types of hermetic bags. The highest value of intensity i1 and i2 (182.3 - 75.8) were observed in the seeds that irradiated with infrared and stored in woven bag and irradiated with UVC and stored in woven bag but the lowest value of intensity one and two (87.2 - 35.6) were observed in the seeds that non irradiated and stored in three layers bag and non-irradiated and stored in seven layers bag. Figure 7 illustrates the relationship between R/G and two different pre-treatment methods of infrared (thermal method) – ultraviolet (irradiation method) using different types of hermetic bags. The highest and lowest value of r\g (1.57-1.27) were observed in the seeds that irradiated with infrared and stored in three layers bag and the seeds that non-irradiated and stored in the woven bag.

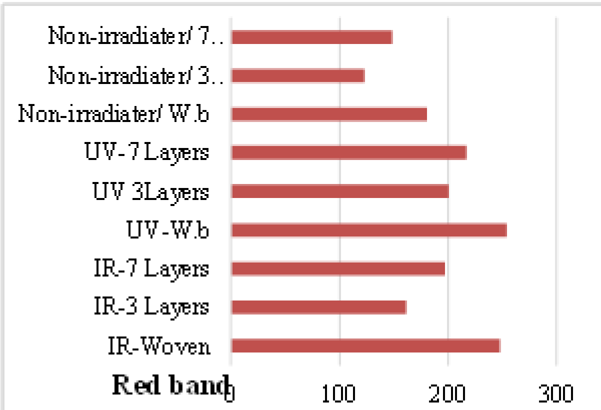

Fig. 2. Relationship between red band and different conditions of cowpea seeds stored day.
Source: Authors' determination.

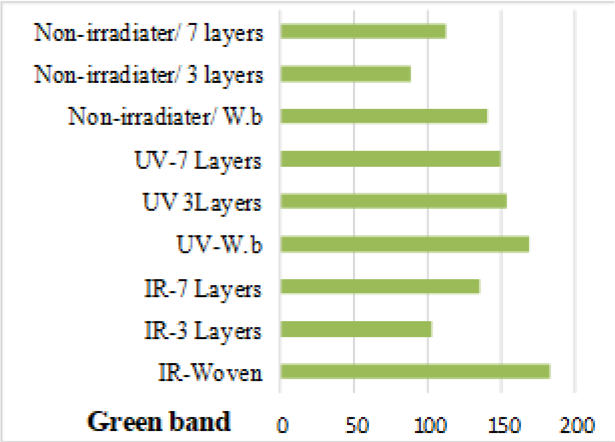

Fig. 3. Relationship between green band and different conditions of cowpea seeds stored day.
Source: Authors' determination.

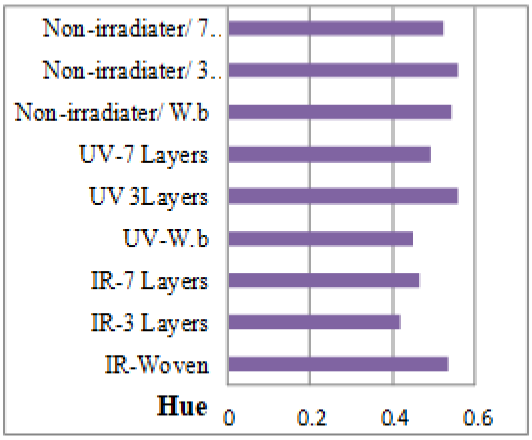

Fig. 4. Relationship between Hue and different conditions of cowpea seeds stored day.
Source: Authors' determination.

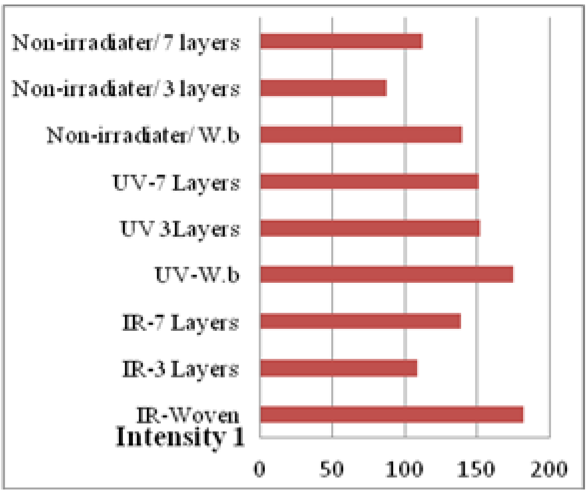

Fig. 5. Relationship between Intensity1 and different conditions of cowpea seeds stored day.
Source: Authors' determination.

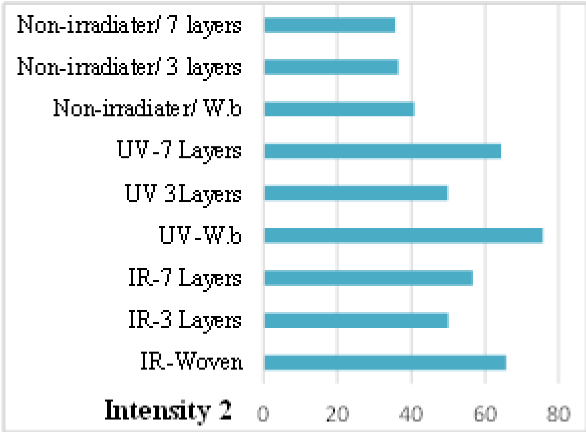

Fig. 6. Relationship between Intensity 2 and different conditions of cowpea seeds stored day.
Source: Authors' determination.

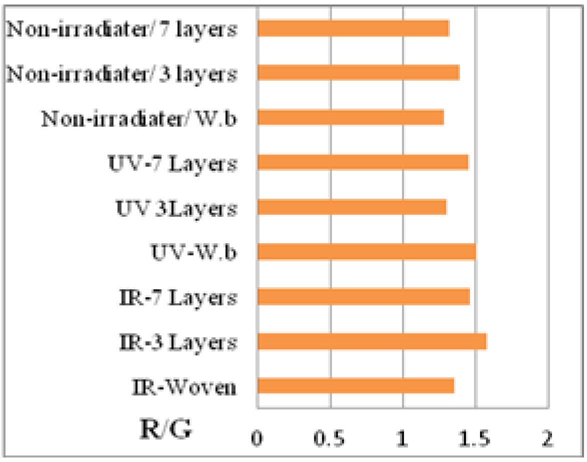

Fig. 7. Relationship between R/G and different conditions of cowpea seeds stored day.
Source: Authors' determination.

CONCLUSIONS

The application of infrared heating of legumes (Cowpea seeds) is gaining importance due to its inherent advantages over conventional heating. Pre-treatment with infra-red of cowpea seeds or ultra-violet radiation and storage of cowpea seeds in hermetic bags (three or seven layers) showed a safe storage result in terms of seeds quality and prevention of microorganisms and insect growth at the FIR and UVC optimum conditions.

When using infra-red pre-treatment for cowpea seeds, the irradiation intensity of 882.67 w/m^2 at exposure time of 15 min get total microbial count 2.3 log cfu/g., and moisture content 8.13 % of cowpea seeds.

When using ultra-violet pre-treatment for cowpea seeds, the irradiation intensity of

3.538 mw/cm^2 at exposure time of 40 min is recommended to get total microbial count 2 log cfu/g., UVC irradiation treatment does not affect the moisture content of the pre-treated cowpea seeds.

Color change for Cowpea seeds after stored effect by FIR and UVC irradiation intensity and hermetic bags (three & seven layers), the differences in Red color band increased by 60.6% when using the seeds that irradiated with UVC radiation and stored in woven bag, the differences in green color band increased by 61.8% when using the seeds that irradiated with FIR radiation and stored in woven bag , the differences in blue color band increased by 65.5% when using the seeds that irradiated with FIR radiation and stored in woven bag , the differences in Hue increased by 7.14% when using the seeds that irradiated with UVC and stored in three layers bag, the differences in intensity I_1 increased by 61.6% when using the seeds that irradiated with FIR and stored in woven bag, the differences in intensity I_2 increased by 60.4% when using the seeds that irradiated with UVC radiation and stored in woven bag and the differences in R/G increased by 9.5% when using in the seeds that irradiated with FIR radiation and stored in three layers bag.

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SAFE STORAGE AND PREVENT SPOILAGE OF FLAX SEEDS

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Abstract

The experiments were conducted directly after the flax harvest season with the object of conditioning the flaxseeds in optimal condition to preserve them in storage as long as possible using different types of storage bags. The measurements during the storage period such as moisture content of seed inside the bags, temperature, the percentage of carbon dioxide , oxygen, peroxide value and free fatty acids, as well as fatty acid ratios. The results showed that, during the storage process, the carbon dioxide concentration with bags (type 7 layers) showed the highest levels of CO_2 concentration which increased from 0.1 to 21.3 %, from 0.1 to 20.5 % and from 0.0 to 19.8 for the non-treated seeds, conduction heat treated and infrared heat treated. seeds respectively after six months of storage and starts to decrease again during the winter months due to lower seeds temperature and respiration rate. While the bags (type 3 layers) showed an increase of CO_2 level from 0.1 to 16.8 %, 0.1 to 16.4 % and from 0.0 to 16 for the non-treated, conduction heat treated and infrared heat treated seeds respectively. However burlap bags showed CO_2 levels ranged from 0.1 to 0.2 % for both treated and non-treated flaxseeds. Also, The total microbial load at the end of storage period approached 885, 861 and 3,512 colonies/g for the non-treated flaxseeds stored in plastic bags 3 and 7 layers and burlap bags respectively. While, the corresponded values for the conduction heat treated flaxseeds were 196, 180 and 2,310 colonies/g respectively. And for the Infrared heat treated seeds were 178, 163 and 1,240 colonies/g respectively. However, at the end of the storage process both bags types 3 and 7 layers recorded lower peroxide value and free fatty acid in comparison with burlap bags during the storage time which indicated good oil quality of the stored seeds. In general, Storage of flaxseeds in both types of tested hermetic bags showed safe storage of flaxseeds with keeping the final quality in comparison with burlap bags.

Key words: *flax, burlap , hermetic bags, free fatty acid, storage, peroxide value, and carbon dioxide*

INTRODUCTION

Flaxseed is considered one of more important of seeds in foodstuffs, as it contains energy, carbohydrates, dietary fibres, proteins, monounsaturated fats, saturated diets, and many vitamins such as riboflavin, thiamine, vitamin B5, vitamin B6, folic acid, and vitamin C, and many mineral salts, such as calcium, iron, magnesium, phosphorus, potassium, zinc, and omega-3 acid.

This part will be covered the heat treatment and storage, Atmosphere storage, hermetic Storage

Thermal treatments are important before storing seeds.

Morais *et al* (2011) [11] examined if the use of heat treatment and storage of the whole brown flaxseed flour would negatively affect the functional and sensory properties or not, such as a decrease in the linolenic acid content, an increase in the lipid peroxide value, and other organoleptic changes such as color and flavor changes. The seeds were treated in an oven at 150°C for 15 minutes. It was milled to obtain a 20 mesh particle size flour and then samples were then stored with or without synthetic antioxidants (BHA and BHT together, at a rate of 100 ppm each), for thirty days. The linolenic acid content and lipid peroxide value were determined and the color and flavor were assessed.

Malcolmson *et al.* (2014) [9] examined storability of two samples from two different types of flaxseeds, one of the linottt cultivar and the other mixed of several varieties. They were stored in paper bags with plastic liners for 128 days at a temperature of 23±2°C, and it was found that the peroxide value in both samples was not significantly affected during the entire storage period. Measurements are at 0, 33, 66, 96 and 128 days. Only the linott sample showed an excess of free fatty acids and this could be due to the presence of immature seeds in the sample.

Herchi *et al*.(2016) [7] studied the effects of heating processes on antioxidant activity of flaxseed hull oil and some quality characteristics. There was a significant decrease in oil stability during heating process. Heating process caused loss of and chlorophyll pigments, total flavanoids, carotenoids and total phenolic acids,. Phospholipids content were less changed compared to other bioactive compounds. Antioxidant activity of flaxseed hull oil decreased during heating process.

Singh *et al.* (2017) [14] A result refer to, seed health during storage has been found to be influenced by the seed quality. Seed storage and retention of seed viability is important consideration in agricultural practice. Poor storage conditions greatly affect seed vigor. The deterioration rate depends on storage condition that is temperature, relative humidity, moisture contents of seed, types of storage container. Types of container also regulate temperature, relative humidity, and seed moisture contents. High temperature, relative humidity, and moisture in the storage environment appear to be principle factors involved in deterioration of seed quality.

Fouda et. Al (2021) [6] using radiation density 331.6 W/m^2 and the exposure time of 15 min for infrared heating are recommended to decrease the moisture content of flaxseeds to the safe level and the percentage of free fatty acids at the range of 0.3 and 0.56±0.02 respectively, and peroxide value at the range of 2.82 and 1±0.02 respectively and heating methods to test the heat conditioning and oil stabilization of flaxseeds and he recognized the heating surface temperature of 105°C and the exposure time of 12 min for conduction heating and

Modified Atmosphere storage:

Meena *et al.* (2017) [10] reported that farmers, traders normally pack the seeds of various crops in either polythene bags, gunny bags or cloth bags before being used for propagation in the next season. Due the seeds sensitivity to oxidation and variation in moisture content during the storage, period many seeds loose viability during the storage. While maintaining the quality, It has been found that storing the fruits, vegetables and dry fruits under vacuum packed bags enhance the shelf life. The seed is utmost necessary to maintain the viability and Vigour, because it is an essential input in agriculture. Many a times, it so happens that the good quality seed is not available to the farmers in time due to various reasons, the average productivity of most of the crop plants has gone down Considerably in the last one decade and one of the reasons for such decline is the poor quality of seeds being used by the farmers. Vacuum packaging has been found to be superior technology in preserving the seed quality of different field crops.

Capilheira *et al. (*2019) [5] stored under different periods, and the containers used were (permeable, hermetic package inside the permeable package and hermetic package inside the permeable package with CO_2 injection) Storage periods (0, 45, 90, 135, 180, 225) in sealed packages and evaluated different packages for storing soybean seeds with or without adding CO_2 (modified atmosphere) The results were the hermetic package, with and without CO_2 injection, decreases the speed of deterioration of soybean seeds. The hermetic package allows a higher physiological quality of soybeans compared to the permeable package, with a storage period of up to 180 days under uncontrolled environmental conditions. The addition of CO_2 inside the hermetic packages favors the maintenance of the physiological quality of soybean seeds in storage. Multi-layer paper was also used with or without injection of CO_2 and the storage inside was evaluated for a period of 225 days and evaluated every 45 days and from the tests that were done during Storage periods are moisture content, germination rate, emergence of seedlings, accelerated aging and electrical conductivity.

Shinde and Hunje (2019) [13] modified atmospheric gases to test seed health and seed viability of kabuli chickpea varieties. The results of study revealed that at the end of 14 months of storage the modified atmospheric gaseous combinations of CO_2 (80%) + N_2 (20%) + O_2 (0%) (C_2) recorded significantly highest seed germination 92.38 % with zero percent of seed infestation and seed infection compared to control C^1 88.75 , 9.38 and 29.49 %, respectively. This technology can be used an alternative to chemicals which is safe, ecofriendly for maintaining quality of organically produced seed and its longevity.

Hermetic Storage of oil seed crops:

Amadou *et al.* (2016) [4] evaluated the performance of hermetic triple layer Purdue improved Crop Storage (PICS) bags for protecting Hibiscus sabdariffa grain against storage insects. When we stored infested H. sabdariffa grain for six months in the woven polypropylene bags typically used by farmers, the Spermophagus population increased 33-fold over that initially present. The mean number of emergence holes per 100 seeds increased from 3.3 holes to 35.4 holes during this time period, while grain held for the same length of time in PICS bags experienced no increase in the numbers of holes. weight loss of grain in the woven control bags was 8.6% while no weight loss was observed in the PICS bags.

Afzal *et al.* (2017) [1] Seed moisture content increased in polypropylene bags while it remained constant in PICS bags. No change in germination was observed in maize seeds stored in PICS bags while in polypropylene bags it was reduced in half when compared to the initial germination. Seed stored in these containers is susceptible to fluctuating seasonal relative humidity and temperature, which promote mold and insect growth. So the performance of Purdue Improved Crop Storage (PICS) bags for maize seed storage during a two-month period is studied. Seed stored in polypropylene bags had higher insect damage with a weight loss of 35% while in PICS bags the infestation was minimal with a weight loss of about 3%. Higher aflatoxin contamination levels were observed in seeds stored in polypropylene than PICS bags.

Walsh *et al*. (2014) [15] noticed reduced physical losses, ability to sell seed (and grain) over a longer period and achieve a better price, improved quality of seed leading to lower seeding rates, improved plant vigor, and – ultimately – improved yields. When used the hermetic storage also provide economic advantages to farmers.

Okolo *et al.* (2017) [12] confirmed the various types and diversity of hermetic storage structures, best practices in terms of use, capacity of best fit, and their consequent unique advantages/shortcomings in terms of cereal grains storage in the tropics were reviewed to aid farmers to make the right choices and achieve better results. And reviewed efficacy, diversity and potentials of hermetic storage (HS) technology and its ability to solve numerous storage related challenges abound, and prevalent in the tropics.

Afzal *et al.* (2019) [2] Stored seeds of moringa were at 8, 10 and 12% seed moisture contents (SMC) in hermetic (super) and traditional (cloth) bags for six months. Highest germination (70%) and vigor were found in hermetically sealed super bag at 8% SMC after storage and estimated the optimum conditions for moringa seed to maintain its quality during storage. Under humid environment, seed storage in cloth bag should not be practiced as it increases equilibrium seed moisture contents, which promotes seed deterioration. Seed stored in hermetically sealed super bags retained higher oil and protein contents as compared to cloth bags.. In conclusion, it is recommended that moringa seeds must be stored in hermetically sealed super bag at 8% SMC for preservation of seed quality.

Kamran *et al.* (2020) [8] stated that, the both genotypes exhibited better seed quality attributes at the first picking, and zeolite beads dried seed to lowest moisture content more quickly than sun-drying. The efficiency of storage systems was evaluated by estimating moisture content and germination potential periodically in the storehouse and later under field conditions. Seeds of both genotypes stored hermetically retained the lowest moisture content, maximum germination potential, and lower fatty acid contents throughout the storage period, as well as performing significantly better in the field by exhibiting early and uniform stand establishment, more fruiting branches and bolls, and higher yield.

Alemu *et al.* (2021) [3] decisions to use different storage methods are poorly understood. so the economics of hermetic grain storage technology among 450 representative small-scale maize farmers, the hermetic bags, being promoted in Ethiopia, could be viable alternatives to traditional methods and insecticides that are commonly used by farmers to store grain. The economics and determinants behind farmers' North Western Ethiopia. Gross margin (GM), and the marginal rate of return (MRR) were employed to estimate the economic costs and benefits of storage methods, while a multivariate probit regression model was employed to analyze the determinants of farmers' decision to store maize with a given storage method. The results show that farmers used a combination of different storage techniques: 19.6% did not store grain, 87.8% used traditional methods with pesticide, and 66.7% used Purdue Improved Crop Storage (PICS) hermetic bags. Farmers who used hermetic bags also used other mentioned storage techniques.

The Egyptian farmer prefer flax cultivation but facing the difficulty in storage and the fast deterioration and damage of seeds also resort to extract oil and fiber from flax. A lot of problems such as increased moisture content of seeds as well as its oil content and other elements made the Lipase enzyme activates and caused oil rancidity and thus reducing seeds quality. The increase in oil rancidity may be caused by a break or crack the seeds that cause the oil release from the seeds during harvesting or as a result of inconvenient storage of the seeds. Methods of seeds pre-treatment prior to storage were varied to thermal, chemical and biological methods. These methods cause a good conditioning of seeds to be proper for safe storage process. It can also control of seeds moisture content, microbial activity, respiration rate and inhibition of enzymes causing rancidity specially for oil seed crops. In Egypt most of traditional storage methods are burlap bags causing seeds moisture absorption, insect infestation and fungal growth. All these factors increased the percentage of deteriorated seeds.

Flax storage considerations were important for deteriorating conditions this work was attempted can contribute to safe storage and prevent spoilage of flax seeds.

MATERIALS AND METHODS

Experiments evaluate two different methods of heating treatment to predict the longest and safe storage period of flaxseeds without biological infestation and minimize the storage losses in hermetic bags. Also Monitoring changes on moisture reduction, heat stabilization, microbial load reduction during storage period 245 day. The sources of heat conduction and Infrared heating was developed to be suitable for seeds prior to storage process. The heat-treated seeds were stored in two different types of storage bags (3&7 layers hermetic bags) and compared with the non-treated seeds. Quality evaluation tests were also conducted for the heat-treated seeds after the heat-treating process and along the storage period.

Sampling Flaxseeds colors is brown. Most types of these basic varieties have similar nutritional characteristics and equal numbers of short-chain Omega-3.

Hermetic bags

Two different types of barriers films were developed for the experimental work. The materials specifications of the barrier films were assessed in the laboratory of Shuman company to assess the most proper film for cowpea storage; the developed films were formed into a shape of bags with capacity of 20 kg/bag.

Methods

Treatments of storage process

The optimum heating condition under conduction and infrared heat treatment was selected for seeds treatment prior to storage process. The heat treated and non-treated seeds were stored in different types of hermetic bags (7 layers – 3 layers) and compared with the seeds stored in the traditional purlab bags. In this experiments we adjust the heating surface temperature of 105C° and the exposure time of 12 min for conduction heating and radiation density 331.6 W/m^2 and the exposure time of 15 min for infrared heating were recommended.

Figure 1 illustrates a schematic diagram for the storage experimental treatments.

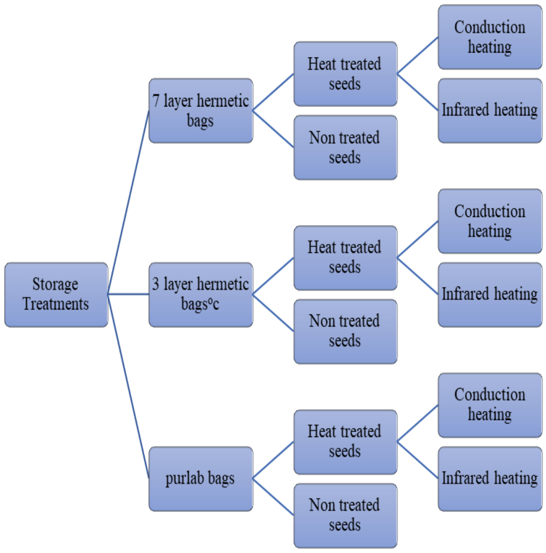

Fig. 1. Experimental treatment for the storage process
Source: Authors' drawing.

Measurements

The final quality (F.F.A – Peroxide value – F.Acids) as determined by the Food Technology Research Institute, Department of Oil Research, Agricultural Research Center were selected for the storage experiments.

Testing condition for different types of multi-layer poly-ethylene bags

The materials specification of the barrier films were assessed in the laboratory of the company. Two different types of barriers films were developed in cooperation with a local company (Shuman Co.). To assess the most proper films for flaxseeds storage, the developed films were formed into a shape of bags with capacity of 50 kg/bag.

The produced bags were filled by the non-treated flaxseeds at initial moisture content 11.11 % d.b. and stored inside storage chamber installed at rice Mechanization center (Kafr El- Sheikh gov.) during the flax harvesting season. The storage process at this stage was done for the treated and non-treated seeds. The evaluation basis of the developed bags included CO_2 percent (%), O_2 percent (%) using the equipment and relative humidity for air in the bags using the equipment seeds moisture content, microbial level and oil quality of the stored seeds in terms of % FFA, Peroxide value and Acidity of the extracted oil.

Experimental procedure for the laboratory scale storage of flaxseeds

1-The required amount of seeds were collected for storage and prepare the store for the storage process.

2-The bags were Catted and welded to bear 10 kg and fill them by the treatments of heat treated flaxseeds and non-treated samples.

3-The filled bags were installed over wooden bars in three stocks (Two stocks represent different types of plastic films and the third stock represents the traditional storage in burlap bags).

4-The percentage of oxygen, carbon dioxide and relative humidity in all bags were measured and taken a sample from each experimental stock to analyze the quality factors changes at one month intervals.

RESULTS AND DISCUSSIONS

Storage of Flaxseeds using different types of hermetic bags

Flaxseeds treated and non-treated were stored in 3 types of bags (3, 7 layers polyethylene hermetic bags and burlap bags) for nine months. The obtained results could be presented as follows:

Seeds Bulk temperature

As shown in Figures 2, 3 and 4. The temperature oscillation decreased with seeds depth inside the tested stocks for both conditions of flaxseeds (treated and non-treated seeds). The recorded seeds bulk temperature for the non-treated seeds ranged from 18 to 30.6, 19 to 31 and 20.6 to 32.8°C for the 7 and 3 layers hermetic bags and the burlap bags respectively. While, the corresponding values for the conduction heat treated seeds ranged from 17.2 to 30, 18.3 to 30.2 and 19.9 to 32°C for the 7 and 3 layers

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hermetic bags and the burlap bags respectively.

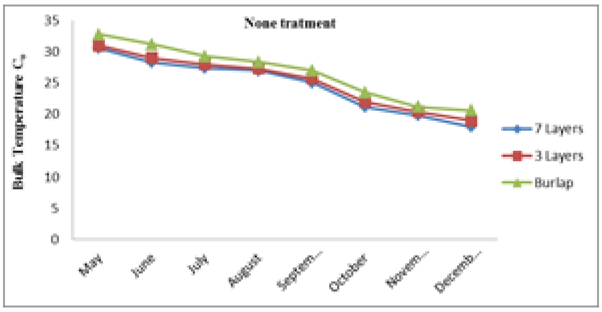

Fig. 2. Effect of the non-treated seeds and bags type on seeds bulk temperature during the storage time.
Source: Authors' determination.

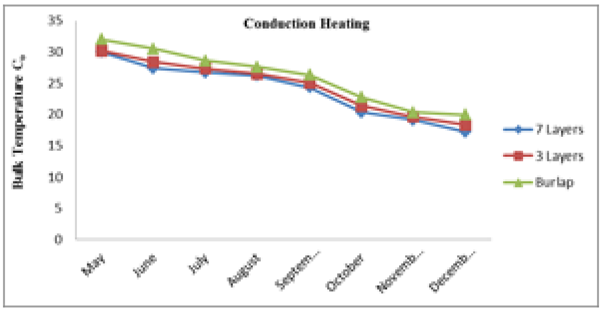

Fig. 3. Effect of conduction heated seeds and bags type on seeds bulk temperature during the storage time
Source: Authors' determination.

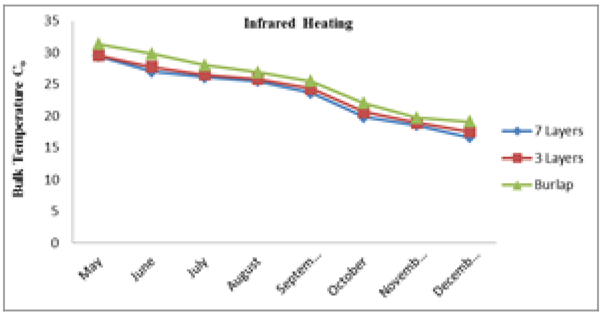

Fig. 4. Effect of the infrared heated seeds and bags type on seeds bulk temperature during the storage time.
Source: Authors' determination.

The bulk temperature of the infrared heat treated seeds ranged from 16.6 to 29.4, 17.5 to 29.5 and 19.1 to 31.3°C for the 7 and 3 layers hermetic bags and the burlap bags respectively.

Seeds Moisture content in different types of bags

The change in seeds moisture content depends on initial moisture content and absorption of moisture content from outside. As shown in Figures 5, 6 and 7 the seeds moisture content decreased in all types of bags.

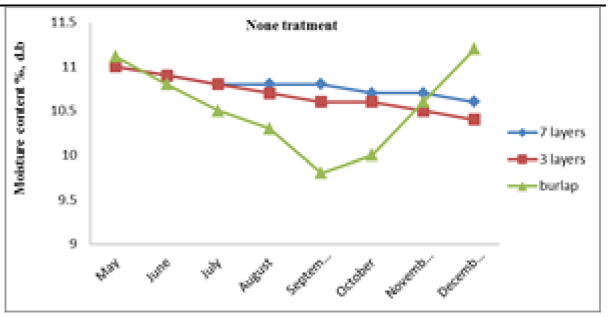

Fig. 5. Effect of the non-treated seeds and bags type on seeds moisture content during the storage time.
Source: Authors' determination.

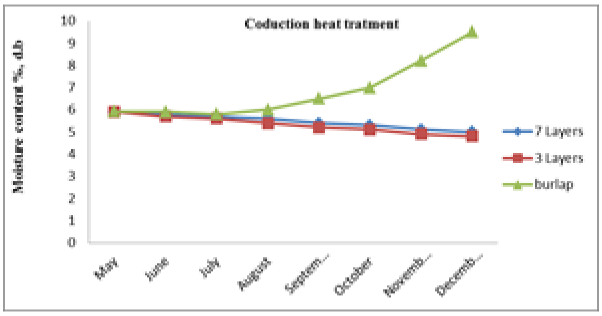

Fig. 6. Effect of conduction heat treated seeds and bags type on seeds moisture content during the storage time.
Source: Authors' determination.

The recorded moisture content for the non-treated seeds ranged from 11 to 10.6, 11 to 10.4 and 11.11 to 11.2 % for the 7 and 3 layers hermetic bags and the burlap bags respectively. While, the values for the conduction heat treated seeds ranged from 5.91 to 5, 5.9 to 4.8 and 5.92 to 9.5 % for the 7 and 3 layers hermetic bags and the burlap bags respectively. The moisture content of the infrared heat treated seeds ranged from 9 to 7.8, 9 to 7.4 and 9.1 to 11.4 % for the 7 and 3 layers hermetic bags and the burlap bags respectively.

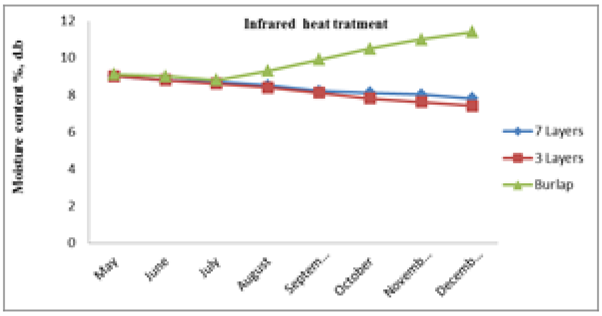

Fig. 7. Effect of infrared heat treated seeds and bags type on seeds moisture content during the storage time
Source: Authors' determination.

CO_2 concentration inside different types of bags

As shown in Figures 8, 9 and 10 . The results show that, The Plastic bags type 7 layers showed the highest levels of CO_2 concentration which increased from 0.1 at the early stage of storage to 21.3 %, from 0.1 to 20.5 % and from 0.0 to 19.8 for the non-treated samples, conduction heat treated and infrared treated samples respectively.

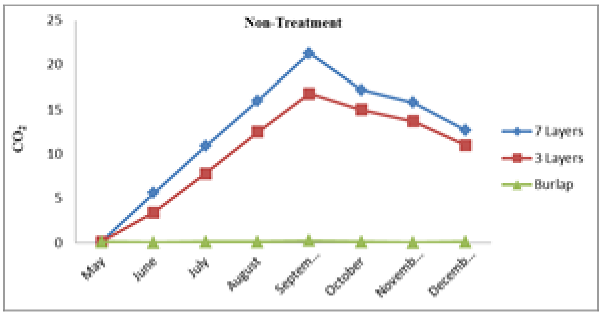

Fig. 8. Effect of the non-treated seeds and bags type on CO_2 concentration during the storage time
Source: Authors' determination.

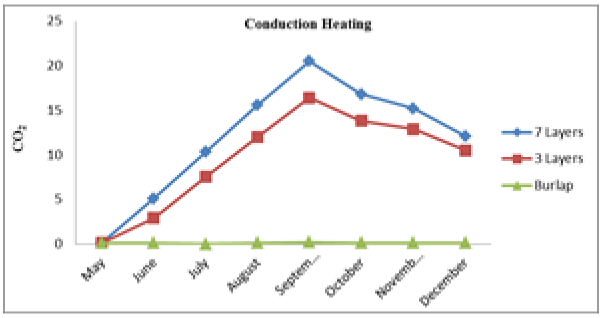

Fig. 9. Effect of conduction heated seeds and bags type on CO_2 concentration during the storage time
Source: Authors' determination.

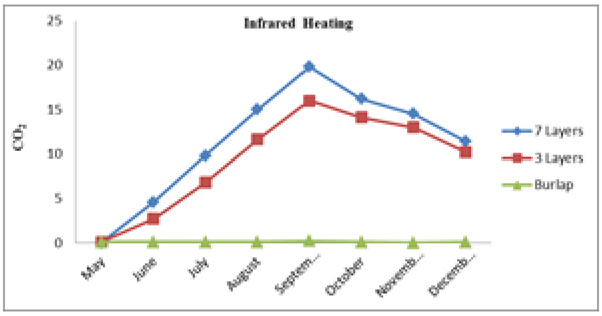

Fig. 10. Effect of infrared treated seeds and bags type on CO_2 concentration during the storage time
Source: Authors' determination.

The above mentioned levels starts to decrease again during the winter months due to lower seeds temperature and respiration rate. The storage bags type 3 layers showed an increase of CO_2 level from 0.1 to 16.8 %, 0.1 to 16.4 % and from 0.0 to 16 for the non-treated, conduction heat treated and infrared treated seeds respectively. However the burlap bags showed CO_2 levels ranged from 0.1 to 0.2 % for both treated and non-treated flaxseeds.

Fungal count during the storage period

The contamination levels recorded at the closing of bags suggest that contamination with molds and other microbes are dependent on the seeds conditions. Under the storage conditions in different types of plastic bags, the mold activity is basically stopped, and also the else mycrotoxine production as the level of CO_2 increased. As shown in Figures 11, 12 and 13 the total microbial load at the end of storage period approached 885, 861 and 3,512 colonies/g for the non-treated flaxseeds stored in plastic bags type 3 and 7 layers and burlap bags respectively. While, the corresponded values for the conduction heat treated flaxseeds were 196, 180 and 2,310 colonies/g respectively. But, the microbial values for the Infrared heat treated flaxseeds were 178, 163 and 1,240 colonies/g respectively This means that, both bags types 3 and 7 layers recorded very close values of total microbial count during the storage time.

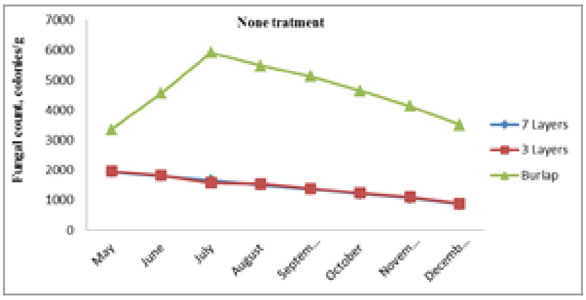

Fig. 11. Effect of the non-treated and bags type on fungal mortality stored seeds during the storage time
Source: Authors' determination.

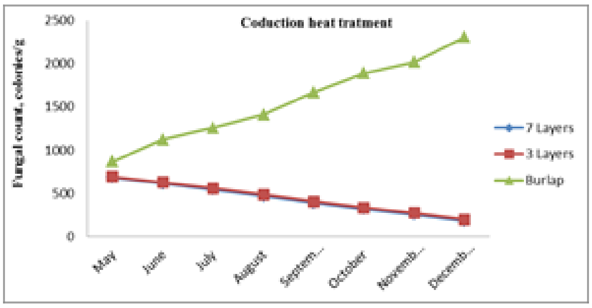

Fig. 12. Effect of the conduction heat and bags type on fungal mortality level during the storage time
Source: Authors' determination.

This may reflect the results of increasing the level of CO_2 and prevention of moisture absorption of hermetic bags which keep the grain in seeds condition and minimize the favorite condition for fungi and other microbial growth.

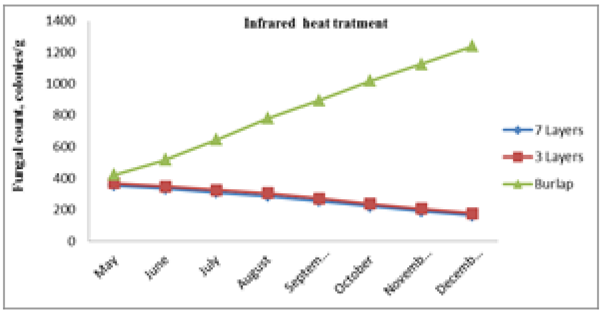

Fig. 13. Effect of the infrared heat and bags type on fungal mortality level during the storage time
Source: Authors' determination.

Seeds oil quality during the storage period

The free fatty Acid (FFA)

The recorded acid value is shown in Figures 14, 15 and 16 at the end of storage period. It was approached 3.34, 3.11 and 7.54 % oleic acid/ Kg for the non-treated flaxseeds stored in plastic hermetic bags type 3 and 7 layers and burlap bags respectively. While, the values for the conduction heat treated flaxseeds were 2.87, 2.74 and 7 % oleic acid/ Kg respectively. But, the values for the Infrared heat treated flaxseeds were 2.75, 2.65 and 6.83 % oleic acid/ Kg respectively.

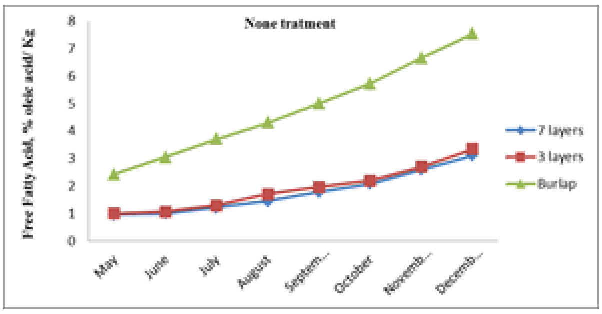

Fig. 14. Effect of the non-heat treated and bags type on free fatty acid values during the storage time
Source: Authors' determination.

This means that, both bags types 3 and 7 layers recorded lower values of free fatty acid during the storage time in comparison with the burlap bags. In general, FFA less than 5 % indicating non-rancidity of the extracted oil.

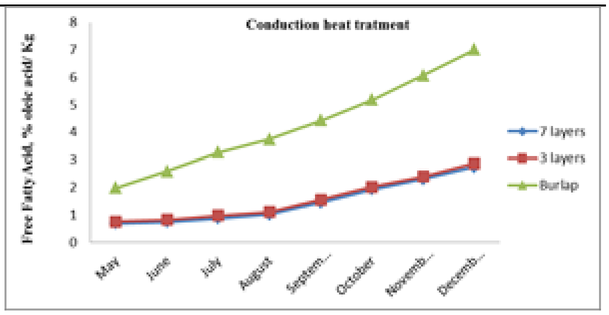

Fig. 15. Effect of the conduction heat and bags type on free fatty acid values during the storage time
Source: Authors' determination.

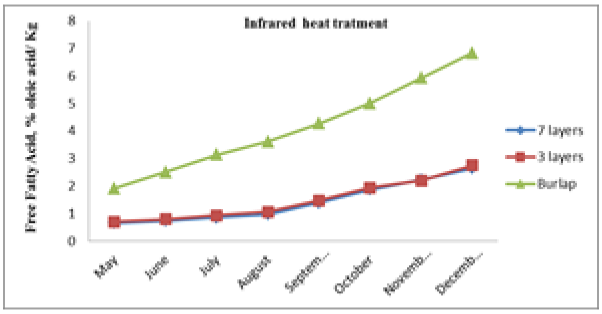

Fig. 16. Effect of the infrared heat and bags type on free fatty acid values during the storage time
Source: Authors' determination.

The peroxide value

The peroxide value recorded as shown in Figures 17, 18 and 19 the peroxide value at the end of storage period approached 22, 21.6 and 28 meqO_2/ Kg Oil for the non-treated flaxseeds stored in plastic bags type 3 and 7 layers and burlap bags respectively. While, the peroxide values for the conduction heat treated stored flaxseeds were 11.4, 11.2 and 17.5 meqO_2/ Kg respectively. And, the values for the Infrared heat treated stored flaxseeds were 10.3, 10 and 17 meqO_2/ Kg Oil respectively.

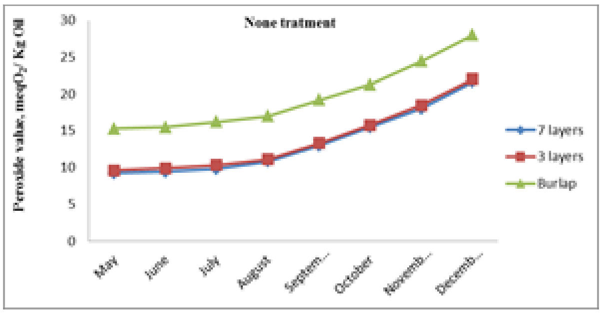

Fig. 17. The change in peroxide values as related to the storage time for the non-treated stored seeds
Source: Authors' determination.

This means that, both bags types 3 and 7 layers recorded lower peroxide values in comparison with burlap bags during the storage time which indicated good oil quality of the stored seeds.

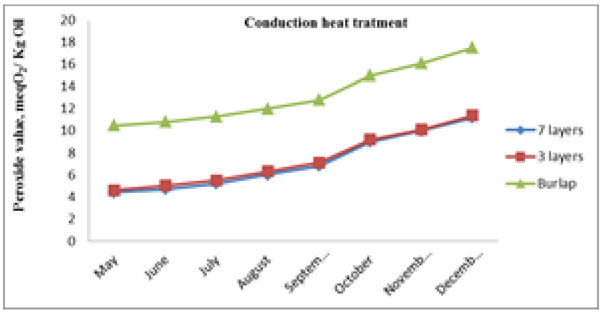

Fig. 18. The change in peroxide values as related to the storage time for the conduction heat treated stored seeds
Source: Authors' determination.

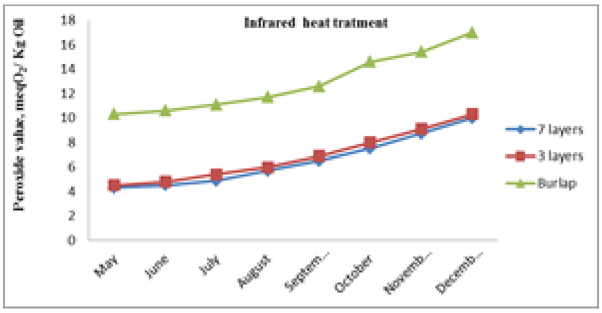

Fig. 19. The change in peroxide values as related to the storage time for the infrared heat treated stored seeds
Source: Authors' determination.

CONCLUSIONS

Two thermal heating units including a rotary dryer and an infrared drying unit were using to storage flax seeds for as long as possible. The heat treated seeds were stored in different types of hermetic plastic bags for 8 months.
Hermetic plastic bag give a good control atmosphere when used for seed storage without deterioration. The principle of this type of bags depending upon full sealing of seeds without moisture absorption and increasing the level of CO_2 inside the bags due to seeds respiration. This condition decreases the level of fungal, microbial and insect growth.

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CARBON FOOTPRINT ESTIMATION IN POULTRY PRODUCTION FARMS

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Abstract

The aim of the experiments was determine the amount of greenhouse gases emitted (nitrous oxide ,ethane and carbon dioxide equivalent) resulting from poultry farms and the effect of these gases on energy productivity of poultry, as well as determining carbon footprint of laying hens production farms to reduce the negative effects of greenhouse gases emissions. In addition to providing necessary information on the performance of laying hens and providing guidance to poultry farmers on the relative merits of different climatic conditions to help set standards for different production traits. The experiments were conducted in one of the farms in the city of Mansoura during the period from June to October 2021 and the capacity of the farm was 40,000 laying hens. The results showed that the amount of methane gas produced from the farm was 0.4 ton CH_4 yr^{-1} and nitrous oxide gas was 0.677 ton N_2O yr^{-1} for manure management. Thus, the total emissions of manure management are estimated at 50.365 tons of CO_2-eq. The amount of greenhouse gas emissions for diesel is 434.59 tons of CO_2-eq. The amount of greenhouse gas emissions (GHG) for the electricity used in the farm is 8 tons of CO_2-eq. In the end, the total amount of emissions produced from the farm is 492.96 tons of CO_2-eq.

Key words: *laying hens, carbon footprint, egg production, methane, nitrous oxide, carbon dioxide equivalent*

INTRODUCTION

In Egypt the poultry industry is one of most important agricultural industries. The labor force consists of approximately 3.5 million permanent workers and approximately two million temporary workers. with an estimated investment of 90 billion LE. The industry provides a significant portion of the country's animal protein supply (white meats and eggs). Local meat production averaged 1,454.856 kt in 2019, while egg production averaged 617.521 kt in the same period. According to (FAO, 2019) [4].

Daghir (2008) said that during the final two decades of the twentieth century, the Middle East experienced significant expansion in the poultry business. Huge expenditures have been made in the construction of environmentally controlled chicken houses with evaporative cooling systems. Over 22 billion table eggs are produced annually in the Arab world, accounting for more than 2.5 percent of total world output (the top producers being Morocco, Algeria, Egypt, and Syria) [2].

Thornton *et al*. (2019) said that greenhouse gases emitted into the atmosphere by human activities and other sources are the primary driver of climate change. Livestock production is a substantial source of air pollution, particularly carbon dioxide (CO_2), methane (CH_4), and nitrogen oxides (NO_x) [10].

Mesarović (2019) stated that that many natural phenomenon influence the temperature of the globe to change and the scientists discovered that the Earth's climate is constantly changing because various natural phenomena such as changes in biotic processes, the Earth's orbit, variations in solar radiation received by the Earth, oceanic, volcanic eruptions and orogenic changes caused by plate tectonics, and the nature of the Earth. Furthermore, human activities have been identified as the major drivers of continuous climate change, often known as global warming [7].

Du Toit *et al*. (2013) said that in comparison to ruminant N_2O emissions, the non-ruminant sector contributes only a small amount to N_2O emissions. The poultry industry is the largest direct N_2O generator in the non-ruminant animal industry, accounting for 92.8 percent of total non-ruminant N_2O emissions [3].

Pratt *et al*. (2014) said that N_2O emissions come from a variety of sources, both direct and indirect, in poultry and pig farms. These include fertilizer storage, urine, and barn flooring surface deposition, and it was discovered that the maximum concentrations of nitrous oxide per 1 kg of LBW were 30% higher in the broiler chicken building than in the pig fattening [8].

Walker *et al*. (2014) showed that a direct link between NH3 emissions and interior temperature. Also identified indoor temperature as the primary variable influencing NH_3 emissions, other factors such as ventilation rate and bird activity may also have an impact on those emissions [11].

Fouda and Kassab (2020) concluded that the amount of heat produced increased from 0.0001 to 0.35 w/egg, and ventilation from 0 to 352 m^3/hr. as the growth period passed from the first day of the twenty-first day, also the amount of carbon dioxide produced from 0.0000158 to 0.04318 lit/hr/mach. With the number of eggs increased from 5,000 to 30,000 eggs, the heat produced increased from 923.4 to 5,540.4 kg/ hr., and carbon dioxide increased from 32 to 190 lit/hr/mach and ventilation from 9 to 54 m^3/hr [5].

Kenny *et al*. (2009) explained that a carbon footprint is a measurement of a person's contribution to global warming in terms of greenhouse gas emissions, and it is expressed in units of carbon dioxide equivalent. It is made up of the total of two parts, The direct or primary footprint is a measurement of our direct carbon dioxide (CO_2) equivalent emissions from the burning of fossil fuels, which includes home energy use, transportation (e.g., automobile and aircraft), and other activities. The indirect or secondary footprint is a measure of the indirect carbon dioxide (CO_2) equivalent emissions from the whole life cycle of the products and services we use, including those associated with their manufacture and final decomposition [6].

Brander (2012) explained that "carbon dioxide equivalent" or "CO_2-eq" is a word used to characterize the different greenhouse gases in a single unit. CO_2-eq is the quantity of CO_2 that will have an equal greenhouse effect for any amount and kind of greenhouse gas. By multiplying the amount of greenhouse gases by the global warming potential, the amount of greenhouse gases may be represented as CO_2-eq. For example, if 1 kilogram of methane is released, it is equivalent to 25 kg of carbon dioxide (1 kg CH_4 * 25 = 25 kg CO_2 equivalent). "CO_2-eq" is a highly useful term for several reasons: it allows "package" of greenhouse gases to be stated as a single quantity; it allows for simple comparison of various packages of greenhouse gases (in terms of the overall effect of global warming) [1].

According to (IPCC) (2006), the carbon dioxide equivalent of a substance is calculated over a set time period and must be provided whenever a global warming potential (GWP) is mentioned. It is anticipated that it will contribute to global warming. For example, the GWP of nitrous oxide over a 100-year period is 298. This indicates that the emission of 1 million ton N_2O is equivalent to the emission of 298 million tons CO_2-eq over a 100-year period. Methane has a global warming value of 25 over 100 years [9].

The research problem was an increase in concentrations of CO_2 and NH_3 inside laying hens housing. Carbon emissions have a negative impact on growth rates in chickens due to increased mortality rates, resulting in lower egg production rates. The study's goal was to evaluate the nitrous oxide, methane, and carbon dioxide equivalents produced by laying hens over a one-year period, as well as the carbon footprint of poultry production.

MATERIALS AND METHODS

The experiment was conducted in a farm in Dakahlia Governorate, city of Mansoura, Egypt. during the month of *June* until *October 2021* A cup 500 chicken was used, and the capacity of the farm was 40,000 laying hens. To estimate the carbon footprint and emissions of other greenhouse gases.

Work was carried out in farm with a closed system for the production of eggs. consists of 6 floors, each floor has two houses without side dimensions (25 m wide x 150 m long), the dimensions of the house (55 m x 12.5 m x 3 m) with a nominal capacity of 4,000 chickens in the production period, the house system is dark for breeding. The drinking system was used on three per line, containing 17 pieces, the length of the piece is 3 meters, and each piece has 12 nipples, one of which is sufficient for 10 birds. And the heating system on an air-driven heater consists of (stainless steel furnace, counter flow heat exchanger, axial fan) and an electronic control box. And a ventilation system that contains 5 hoods, each with a length of 140 cm width of 140 cm width, circulating air for 44,000 m^3/h with 6 brushes. Made of stainless steel, 3-phase electrically operated, evaporative cooling system was used, and the feeding system is a closed floor chain feeding system.

A set of mathematical equations was used to calculate the amount of emissions generated from poultry farms such as methane gas, nitrous oxide, carbon dioxide and carbon dioxide equivalent, as presented below.

-CH4 emissions from manure management:

$$\mathbf{CH_{4}}_{\mathbf{manure}} = \sum\nolimits_{(\mathbf{T})} \frac{(\mathbf{EF_{(T)}} * \mathbf{N_{(T)}})}{\mathbf{10^6}}$$

where:

$CH_{4Manure}$ = Measured in (Gg CH_4 yr^{-1}), it is CH_4 emissions for a layers.

$N_{(T)}$ = number of hens.

$EF_{(T)}$ = Measured in (kg CH_4 $head^{-1}$ yr^{-1}), it is emission factor for layers.

-Annual N excretion rates:

$$\mathrm{Nex}_{(\mathrm{T})} = N_{\mathrm{rate(T)}} * \frac{TAM}{1{,}000} * 365$$

where:

$Nex_{(T)}$ = Measured in (kg N hen^{-1} yr^{-1}), It is annual N secretion for layers.

$N_{rate\ (T)}$ = Measured in (kg N (1,000 kg hen $mass)^{-1}$ day^{-1}), It is default N secretion rate.

$TAM_{(T)}$ = Measured in (kg $animal^{-1}$), It is standard layers mass.

-Emissions of direct N_2O from manure management:

$$\boldsymbol{N_2O_{D(mm)}} = \left[\sum_S \left[\sum_T \left(\boldsymbol{N_{(T)}} * \boldsymbol{Nex_{(T)}} * \boldsymbol{MS_{(T,S)}}\right)\right] * \boldsymbol{ES_{3(S)}}\right] * \frac{\mathbf{44}}{\mathbf{28}}$$

where:

$N_2O_{D\ (mm)}$ = Measured in (kg N_2O yr^{-1}), It is direct N_2O emissions from hen.

$Nex_{(T)}$ = Measured in (kg N $animal^{-1}$ yr^{-1}), it is annual average N secretion per hen.

$EF_{3(S)}$ = Measured in (kg N_2O-N/kg N), it is emission factor for direct N_2O emissions.

$MS_{(T,S)}$ = Measured in (dimensionless), it is part of total annual nitrogen secretion for layers.

$N_{(T)}$ = number of hens

S = with litter

44/28 = diversion of $(N_2O\text{-}N)_{(mm)}$ emissions to $(N_2O)_{(mm)}$ emissions.

-N Losses because volatilization from manure management:

$$\mathbf{N_{volatilization-MMS}} = \sum_S \left[\sum_T \left[(\mathbf{N_{(T)}} * \mathbf{Nex_{(T)}} * \mathbf{MS_{(T,S)}}) * \left(\frac{\mathbf{Frac_{GasMS}}}{\mathbf{100}}\right)_{(T,S)}\right]\right]$$

where:

$N_{volatilization\text{-}MMS}$ = Measured in (kg N yr^{-1}), it is amount of manure nitrogen that lost because Volatilization of NH_3 and NO_x.

$N_{(T)}$ = number of hens.

MS (T,S) = Measured in (dimensionless), it is part of total annual nitrogen secretion for layers.

$Nex_{(T)}$= Measured in (kg N hen^{-1} yr^{-1}), it is annual average N secretion per hen.

$Frac_{GasMS}$ = percent of manure nitrogen for hens that volatilises as NH_3 and NO_x.

-Indirect N_2O emissions because volatilisation of N from manure management:

$$\mathbf{N_2O_{G(mm)}} = (\boldsymbol{N}_{\mathbf{volatilization-MMS}} * \boldsymbol{EF_4}) * \frac{\mathbf{44}}{\mathbf{28}}$$

where:
$N_2O_{G\ (mm)}$ = Measured in (kg N_2O yr^{-1}), it is indirect N_2O emissions because volatilization of hen.
EF_4 = Measured in (kg NH_3-N + NO_x-N volatilized)$^{-1}$, it is emission factor for N_2O emissions.

-Carbon dioxide equivalent (CO_2e):

$$\text{Kg } CO_2e = \text{Kg } CH_4 * 25 + \text{Kg } N_2O * 298 + \text{Kg } CO_2$$

-GHG emissions from generator:

$$E = \frac{Q \times EC \times EF}{1{,}000}$$

Where:
E = Measured in (ton CO_2-eq), it is the total emissions released.
EC = Measured in (G/kl), it is the energy content factor of the fuel
Q = Measured in (kl), it is the quantity of fuel combustion.
EF = Measured in (kg CO_2-eq / GJ), it is emission factor for the fuel.

-GHG emissions from purchased main electricity grid:

$$\mathbf{E} = \frac{\mathbf{Q \times EF}}{\mathbf{1{,}000}}$$

where:
E = Measured in (ton CO_2-eq), it is the scope 2 emissions measured.
EF = Measured in (0.72 kg CO_2-eq / kW. hr), it is the emission factor for the electricity in the farm.
Q = Measured in (kW. hr), it is quantity of electricity purchased from the electricity grid.

RESULTS AND DISCUSSIONS

Emissions of CH_4 for layers from manure management by (ton CH_4 yr^{-1})

Figure 1 depicts Emissions of CH_4 were calculated for laying hens, it was estimated at 0.1 ton of methane per year for 10,000 chickens, which is less than the standard value of methane gas, which is equal to 0.2 ton of methane per year while the emissions per year for 100,000 chickens were equal to 1 ton CH_4 yr^{-1} and thus the amount of methane emitted from the farm is equal to 0.4066 ton of methane per year.

Emissions of CH_4 for layers from manure management by (ton CO_2-eq)

Figure 2 depicts Emissions of CH_4 for laying hens, for 10,000 chickens, it was estimated at 2.5 ton CO_2-eq**.**

N Losses because volatilization from manure management

Figure 3 depicts the amount of nitrogen that lost was calculated for laying hens and it was estimated at 8.619 ton nitrogen per year for 10,000 chickens. Thus, the amount of nitrous emitted from the farm equals 34.479 ton nitrogen per year.

Direct N_2O emissions for hen from manure management by (ton N_2O yr^{-1})

Figure 4 depicts the direct nitrous oxide emissions were calculated for laying hens, for 10,000 chickens it was estimated 0.033 ton N_2O yr^{-1} chickens, while for 100,000 chickens the emissions were equal to 0.0338 ton N_2O yr^{-1}. Thus, the amount of source nitrous oxide emitted from the farm equals 0.137 ton N_2O yr^{-1}

Direct N_2O emissions for hen from manure management by (ton CO_2-eq)

Figure 5 depicts the direct nitrous oxide emissions; it was estimated at 10.09 ton CO_2-eq 10,000 chickens, while the emissions per year for 100,000 chickens were equal to 100.91 ton CO_2-eq. Thus, the amount of source nitrous oxide emitted from the farm equals 40.98 ton of nitrous oxide per year.

Indirect N_2O emissions due to volatilisation of N for hen by (ton N_2O yr^{-1})

Figure 6 depicts the indirect nitrous oxide emissions were calculated because nitrogen volatilization from manure management for laying hens, it was estimated at 0.136 ton N_2O yr^{-1} for 10,000 chickens, while the emissions per year for 100,000 chickens were equal to 1.35 ton N_2O yr^{-1}. Thus, the amount of indirect nitrous oxide emitted from the farm equals 0.554 ton of nitrous oxide per year.

Indirect N_2O emissions due to volatilisation of N for hen by (ton CO_2-eq)

Figure 7 depicts the indirect nitrous oxide emissions due to nitrogen volatilization from manure management for laying hens, it was estimated at 40.36 ton CO_2-eq 10,000 chickens While the emissions per year for 100,000 chickens were equal to 403.65 ton CO_2-eq. Thus, the amount of indirect nitrous oxide emitted from the farm equals 2.62 ton CO_2-eq

Fuel emissions from laying hens farms

Figure 8 shows the emissions of diesel use from the use of heating heaters and generators from the farm and was calculated for laying hens and was estimated at 108.64 ton CO_2-eq for 10,000 chickens. Thus, the amount of diesel emissions from the farm is equal to 434.59 ton CO_2-eq.

Emissions from electricity from laying hens farms

Figure 9 shows the emissions of electricity use from the farm and was calculated for laying hens and was estimated at 2 ton CO_2-eq for 10,000 chickens. Thus, the amount of electricity emissions from the farm is equal to 8 ton CO_2-eq.

Total CO_2-eq Emissions from Poultry Farms

Figure 10 depicts Total CO_2-eq emissions were calculated from poultry farms, it was estimated at 123.23 ton CO_2-eq for 10,000 chickens. Thus, the amount of CO_2-eq emitted from the farm equals 493.96 ton CO_2-eq.

The relationship between laying hens number and total CO_2-eq emissions can be expressed by regression equation as:

$y = 0.164x - 0.0228$ $R^2 = 1$

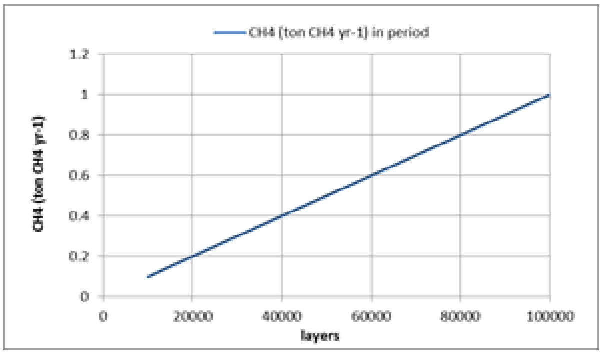

Fig. 1. Emissions of CH_4 for layers from manure management by (ton CH_4 yr^{-1}).
Source: Authors' determination.

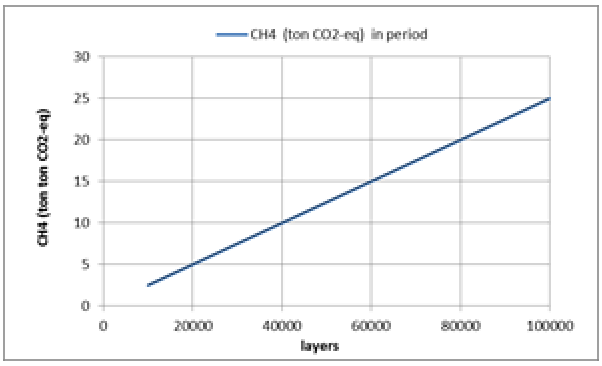

Fig. 2. Emissions of CH_4 for layers from manure management by (ton CO_2-eq).
Source: Authors' determination.

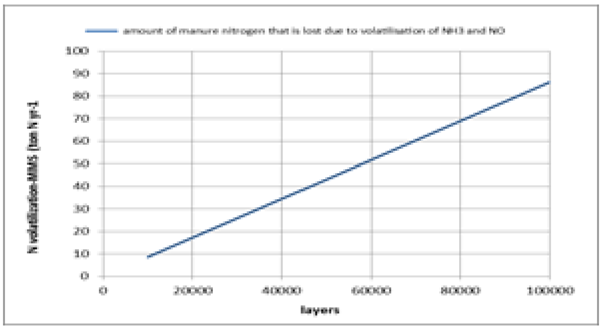

Fig. 3. N losses because volatilization for hen
Source: Authors' determination.

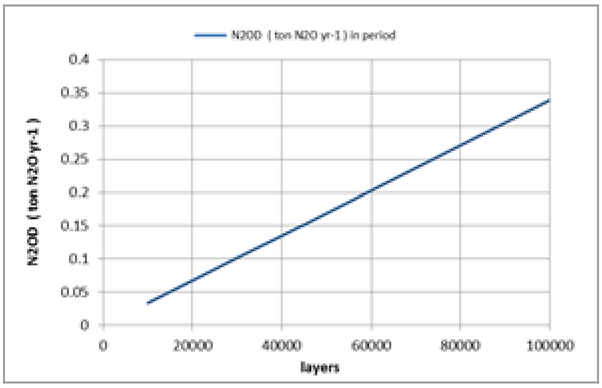

Fig. 4. Direct N_2O emissions for hen(ton N_2O yr^{-1}).
Source: Authors' determination.

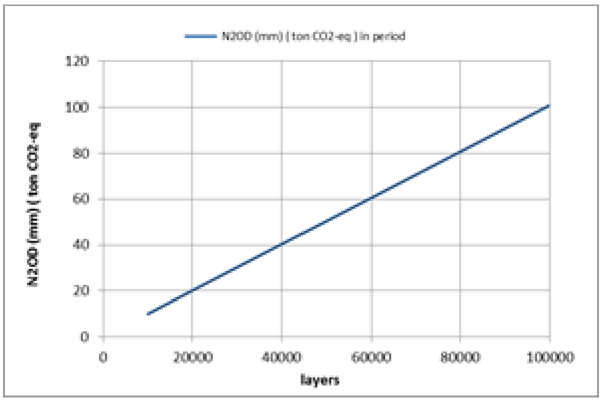

Fig. 5. Direct N_2O emissions for hen (ton CO_2-eq)
Source: Authors' determination.

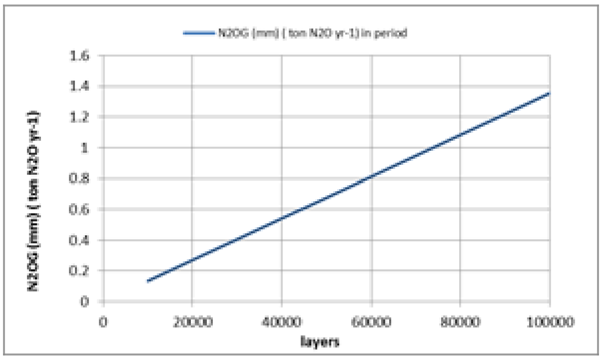

Fig. 6. Indirect N_2O emissions because volatilization of N for hen (ton N_2O yr^{-1}).
Source: Authors' determination.

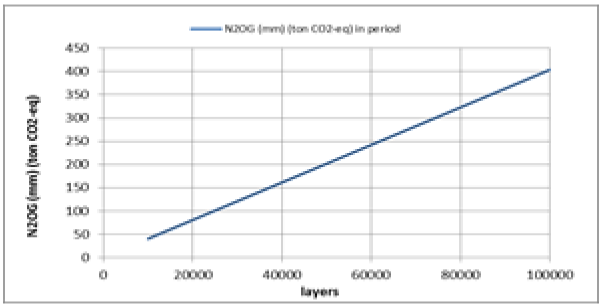

Fig. 7. Indirect N_2O emissions because volatilization of N for hen (ton CO_2-eq).
Source: Authors' determination.

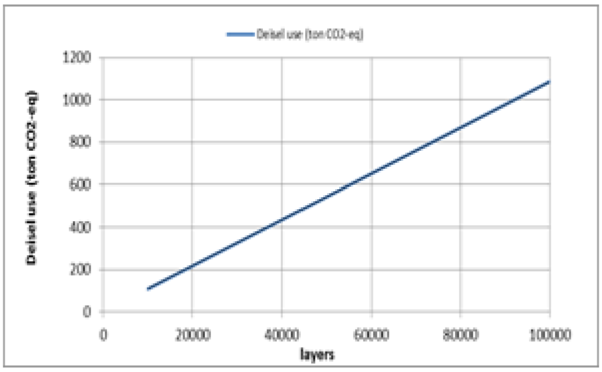

Fig. 8. Diesel use emissions for hen (ton CO_2-eq)
Source: Authors' determination.

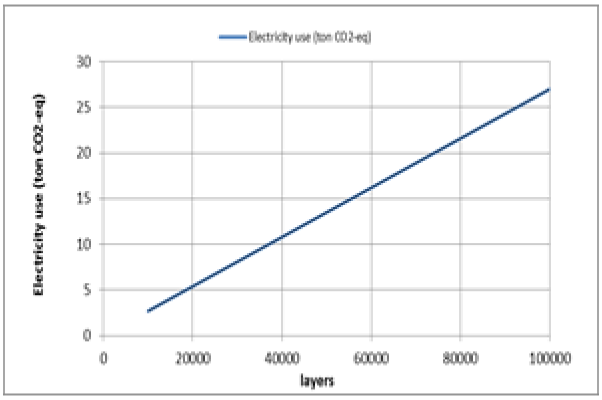

Fig. 9. Electricity use emissions for number of laying hens
Source: Authors' determination.

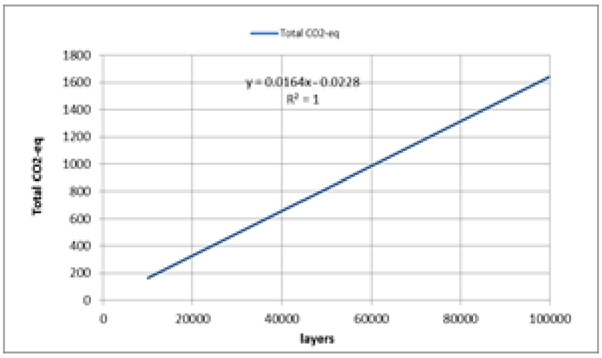

Fig. 10. Total CO_2-eq Emissions (ton CO_2-eq) for layers
Source: Authors' determination.

CONCLUSIONS

The amount of methane gas produced from the farm was 0.4 ton CH_4 yr^{-1} and nitrous oxide gas was 0.677 ton N_2O yr^{-1} for manure management. Thus, the total emissions of manure management are estimated at 50.365 tons of CO_2-eq. The amount of greenhouse gas emissions for diesel is 434.59 tons of CO_2-eq. The amount of greenhouse gas emissions for the electricity used in the farm is 8 tons of CO_2-eq. In the end, the total amount of emissions produced from the farm is 492.96 tons of CO_2-eq.

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ANALYSIS OF THE VEGETABLE SECTOR IN GIURGIU COUNTY, ROMANIA

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Abstract

This paper aims to present the evolution of agriculture in Giurgiu County in the period 2016-2020, analyzing in particular the production of vegetables. In order to highlight the main trends in agricultural production, statistical data were analyzed for the following vegetables: potatoes, tomatoes, eggplant, white cabbage, peppers and garlic. The total vegetable production registered at the level of Giurgiu county increased by 22,649 tons, from 63,896 tons in 2016 to 86,545 tons in 2020, the highest increase being registered for tomatoes, at the level of 2020, registering an increase of approximately 99% compared to the production obtained in 2016, this was largely due to the financial support provided, both through direct payments and the possibility to access European funds to make investments in this sector. At the level of this year, Giurgiu county is on the fourth place in the top of the counties with the most beneficiaries of the forms of support granted to vegetable growers within the program to support the production of vegetables in protected areas, their share being 7.1% of the total number of beneficiaries at national level, and the amount due related to the area was 2.02 million euros, representing 6.6% of the total amount allocated to the program at national level.

Key words: *vegetables, cultivated area, production, price, financial support, Giurgiu County, Romania*

INTRODUCTION

At the level of Romania, the vegetable market is strongly fragmented, the transfer of raw materials from producer to processor, distributor and consumer being deficient, due to the precarious form of organization. The health crisis caused by the Covid-19 pandemic has exacerbated this fragmentation, with imports showing an increasing trend, leading to a weak trade balance at national level. Vegetables are imported mainly as fresh products, but also as frozen products, and market demand is generally constant throughout the year, with the exception of the holiday season, when demand increases slightly [3, 10, 11, 13].

In 2018, tomatoes were the product with the lowest degree of self-sufficiency insurance, this being 73%. In this context, vegetable production needs to increase in order to better meet the needs of the internal market and to support exports to the EU market [2, 11].

A major vulnerability of the vegetable sector is represented by the poor organization of local producers (less than 1% of producers are part of producer groups or organizations, the EU average being 45%). In our country only 4 of the 24 existing producer organizations currently participate in the operational program within the common market organization (cooperatives). Reluctance to associate, poor consultancy, a lack of understanding of the advantages of the common organization of the agricultural market and the difficulty of complying with contracts are just some of the factors which contribute to this situation [2, 9].

The purpose of this paper is to present an overview of the vegetable sector in Giurgiu County in the period 2016-2020, analyzing the cultivated area, production and average annual prices for the main vegetable crops. During the paper were presented and analyzed data on the number of producers benefiting from the support provided to vegetable growers in 2021 and the amounts granted, through programs to support vegetable production in protected areas, data officially presented by the Agricultural Directorate of Giurgiu County.

MATERIALS AND METHODS

The research is based on statistical data provided by the Giurgiu County Directorate of Statistics and the Agricultural Directorate of Giurgiu County, for the period 2016-2020. During the research, the following statistical indicators were calculated and analyzed:

Arithmetic mean, calculated as the ratio between the sum of the values in the data series and the number of years taken into account.

$$m=\frac{x_1+x_2+\cdots+x_n}{n}$$

The standard deviation that indicates how much the values are dispersed from the mean.

$$\partial=\sqrt{\frac{\sum(xi-\overline{x})^2}{n-1}}$$

where:
∂ = standard deviation;
xi = data series values over a number of years;
n = number of years considered.

Coefficient of variation:

$$C=\frac{\partial}{\overline{X}}*100$$

It takes values between 0 and 100%. Between 0-10% attests a higher degree of homogeneity of the series, between 10-20% - medium variation; over 20% - large variation.

The annual growth rate, it shows what is the annual growth of the analyzed phenomenon:

$$r=\sqrt[n-1]{\prod\left(\frac{p\,n}{p\,n-1}\right)}-1$$

r = average annual growth rate;
$\prod$pn/pn-1 = chained growth indicators [4].

RESULTS AND DISCUSSIONS

Statistical data on Giurgiu County, at the level of 2020, attest to the fact that the total agricultural area is 259,251 hectares, representing 3.1% of the total agricultural area of Romania (8,375,739 hectares), the categories of agricultural use being diverse, indicating a potential high agricultural.

Giurgiu County is a predominantly agricultural county, the value of vegetable agricultural production registering an upward trend, in 2019 there was an increase of 53% compared to 2016, from 958,924 million lei to 1,470,195 million lei. From the calculation of the linear regression it results that the value of the vegetal agricultural production in the county increased on average by approx. 17,518 million lei per year (Figure 1).

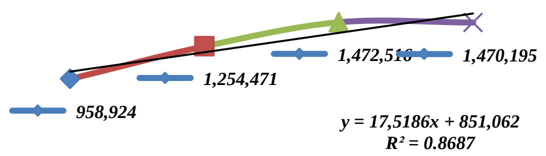

Fig. 1. The evolution of the value of the vegetal production in Giurgiu county (millions of lei)
Source: Giurgiu County Directorate of Statistics [7].

However, the county is facing a lack of agricultural productivity, generated by: poor infrastructure, small size of agricultural holdings and other structural factors such as: the practice of subsistence farming. More than half of the county's population is active in subsistence agriculture, the county having an aging population, registering a negative evolution of the labor supply. Thus, the main economic activity, agriculture, is practiced in a percentage of over 50% in subsistence regime, by the aging population [5].

The county is representative for the plain area of the country and has a very high potential for vegetable production both in the field and in protected areas, due mainly to the high natural fertility of the chernozem soil, but also the temperate continental climate. However, the producers in the county face problems in terms of the market, the grouping of vegetable growers in associations and producer groups is a great opportunity to capitalize on products at much better prices, with the ability to negotiate prices and achieve deliveries to supermarkets/ hypermarkets [6].

An example in this sense is represented by the BioProd Colibași cooperative from Giurgiu county. The establishment of the cooperative in Colibași commune started from the evaluation of the horticultural potential of the area near the commune, where approximately 500 vegetable growers work, cultivating an area of about 400 hectares. At the level of 2017, the year in which the cooperative was established, it consisted of 6 members, with an area of 7 hectares of vegetables, as well as 40 hectares of melons. Their small number in the cooperative was largely determined by the fact that most young farmers had access to European funds with the status of legal entities, which did not give them the legislative right to join the cooperative. The purpose of setting up the BioProd Colibasi cooperative was to attract non-reimbursable European funds for the establishment of a vegetable processing plant and a warehouse for sorting and packaging products [1]. BioProd Colibasi Agricultural Cooperative, founded in 2017, in order to find a market for vegetable growers in the commune, had in 2020 a turnover of 29.2 million lei, almost five times higher than in 2018 and profit of almost one million lei. (Table 1).

Table 1. Financial data from BioProd Colibasi Agricultural Cooperative, Giurgiu County, Romania.

Years	***Fiscal value***	***Nr. employees***	***Profit / loss***
2017	0	0	-12,072
2018	6,304,951	0	-532,166
2019	28,803,883	0	1,044,368
2020	29,177,467	29	93,540

Source: website of the Ministry of Finance, Accessed on 23.09.2021 [8].

Analyzing the area cultivated with the main vegetables in Giurgiu County, the following were noted: the largest area was recorded in tomatoes, in the period 2016-2020, registering an average of 1,054 hectares and limits between 1,021 hectares in 2016 and 1,081 hectares in 2019.

Table 2. The area cultivated with vegetables at the level of Giurgiu county (hectares)

Nr. crt.	***Specification***	***Years***					***Minimum***	***Maximum***	***Average***	***Standard deviation***	***Coefficientul of variation (%)***	***Annual growth rate (%)***
		2016	***2017***	***2018***	***2019***	***2020***						
1.	Potatoes - total	580	577	579	581	579	577	581	579.2	1.48	0.26	-0.04
2.	Tomato	1,021	1,042	1,057	1,081	1,069	1,021	1,081	1,054	23.43	2.22	1.16
3.	Eggplants	335	330	347	346	341	330	347	339.8	7.26	2.14	0.44
4.	White cabbage	716	714	865	865	857	714	865	803.4	80.77	10.05	4.60
5.	Pepper	503	503	518	508	466	466	518	499.6	19.76	3.95	-1.89
6.	Garlic	253	252	252	252	241	241	253	250	5.05	2.02	-1.21

Source: Giurgiu County Directorate of Statistics [7].

At the opposite pole, with the smallest area was garlic, it recorded limits between 241 hectares in 2020 and 253 hectares in 2016 and an average area of 250 hectares. Following the analysis of the statistical indicators calculated for the area cultivated with vegetables, the following aspects were observed: the standard deviation registered limits between 1.48 hectares for potato cultivation and 80.77 hectares for white cabbage. The coefficient of variation indicates a homogeneous series of data for the area cultivated with potatoes, tomatoes, eggplants, peppers and garlic, with the exception of white cabbage cultivation which showed a medium variation of the data series. The annual growth rate registered negative values for potato, pepper and garlic crops, which means a decrease in areas at the level of the analyzed period (Table 2).

There was a downward trend, with small oscillations, of areas cultivated with potatoes, peppers and garlic. Regarding the cultivated area with tomatoes, eggplants and white cabbage, the evolution trend was an ascending one, registering increases at the level of the analyzed period. The main cause that influenced the increase of the area cultivated with tomatoes was the granting of financial support through the "tomato program", which since 2021 has expanded and includes four types of vegetables: cabbage, eggplant, cucumbers and peppers. The tomato program has been running for a period of 4 years, the

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amount of support provided during this period at national level being 172 million euros [12, 14].

At the level of Giurgiu county, through the tomato program, a number of 6,896 vegetable growers benefited from financial support, the value of the support being 88,844,686.68 lei (Table 3).

In 2018, a number of 1,813 producers were enrolled in the program, of which 1,495 in the first cycle and 318 in the second cycle. Of the 1,813 registered producers, 37 did not complete the program, resulting in a number of 1,776 beneficiaries this year (Table 3).

Table 3. Number of beneficiaries and support provided within the tomato program in Giurgiu county in the period 2017-2020

Nr. Crt.	Years	Number of beneficiaries	Amount per beneficiary (lei)	The total amount of support (lei)
1.	2017	1,301	13,481.40	17,539,301,4
2.	2018	1,776	13,797.90	24,505,070.4
3.	2019	2,058	13,991.40	28.794.301,2
4.	2020	1,761	10,224.88	18,006,013.7
Total		**6,896**	**51,495.58**	**88,844,686.68**

Source: Giurgiu County Agricultural Directorate, http://www.directiaagricolagiurgiu.eu/ [7].

The highest production was recorded for tomatoes, in the analyzed time the tomato production registered on average 25,346.4 tons, ranging between 16,034 tons in 2016 and 31,843 tons in 2020, the evolution trend being an upward one.

A significant production was also recorded for the white cabbage crop, it recorded an average of 19,525 tons, with limits between 16,822 tons in 2016 and 21,946 tons in 2020 (Table 4).

On the other hand, the lowest yields were obtained for crops of potatoes and garlic. Potato production recorded an average period of 5,740.2 tons, with variations ranging from 4,685 tons in 2020 to 7,297 tons in 2016. In terms of garlic cultivation, production recorded an average of 1,618.4 tons, ranging between 1,284 tons in 2016 and 2021 tons in 2018.

Analyzing the statistical indicators, the following were found: the coefficient of variation recorded for peppers, respectively 7.67%, was in the range 0-10% and attests a higher degree homogeneity of the data series.

In the tomato crop, a large variation of the data was observed in the analyzed time interval, the coefficient of variation of 25.53% exceeding the value of 20%. For the other cultures, the coefficient of variation was in the range of 10-20%, indicating a medium variation. With the exception of the potato crop where a negative annual growth rate of -10.49% was registered, the other crops registered increases of the total production, the most accentuated being of 18.71% for tomatoes (Table 4).

Table 4. Total vegetable production in Giurgiu county (tons)

Nr. crt.	*Specification*	*Years*					*Minimum*	*Maximum*	*Average*	*Standard deviation*	*Coefficientul of variation (%)*	*Annual growth rate (%)*
		2016	*2017*	*2018*	*2019*	*2020*						
1.	Potatoes - total	7,297	6,063	5,592	5,064	4,685	4,685	7,297	5,740.2	1,014.95	17.68	-10.49
2.	Tomato	16,034	21,703	30,072	27,080	31,843	16,034	31,843	25,346.4	6,471.82	25.53	18.71
3.	Eggplants	4,920	6,374	7,502	6,540	6,514	4,920	7,502	6,370	926.50	14.54	7.27
4.	White cabbage	16,822	17,746	21,598	19,513	21,946	16,822	21,946	19,525	2,271	11.63	6.87
5.	Pepper	6,632	7,116	7,992	7,773	7,028	6,632	7,992	7,308.2	560.43	7.67	1.46
6.	Garlic	1,284	1,399	2,021	1,905	1,483	1,284	2,021	1,618.4	325.01	20.08	3.67

Source: Giurgiu County Directorate of Statistics [7].

Analyzing the evolutionary tendencies of the vegetable production analyzed at the level of the period 2016-2020 in Giurgiu County, the following were noted: the only crop that showed a downward evolutionary trend was that of potatoes, which registered a decrease of 36% in 2020 (4,685 tons) compared to 2016 (7,297 tons), the other crops analyzed showed an upward trend, registering increases in the analyzed period, the most significant increase, respectively 99%, being obtained from tomatoes.

According to statistical data, at the level of the period 2016-2020, the average annual prices of the main vegetable products showed an upward trend (Table 5).

Table 5. Average annual prices of the main vegetables in Romania (lei/kg)

Nr. crt.	*Specification*	*Years*					*Minimum*	*Maximum*	*Average*	*Standard deviation*	*Coefficientul of variation (%)*	*Annual growth rate (%)*
		2016	*2017*	*2018*	*2019*	*2020*						
1.	Early, semi-early and summer potatoes	1.11	1.12	1.61	2.06	1.7	1.11	2.06	1.52	0.41	26.73	11.25
2.	Autumn potatoes	1.4	1.34	1.37	2.09	1.92	1.34	2.09	1.62	0.35	21.77	8.22
3.	White cabbage - early	1.24	1.47	2.69	2	1.93	1.24	2.69	1.87	0.56	29.95	11.70
4.	White cabbage - autumn	1.41	1.35	1.84	1.75	1.66	1.35	1.84	1.60	0.21	13.33	4.17
5.	Tomatoes	3.07	3.19	3.09	3.69	4.16	3.07	4.16	3.44	0.48	13.81	7.89
6.	Long peppers - capia type	3.18	3.82	4.44	4.47	4.8	3.18	4.8	4.14	0.64	15.55	10.84
7.	Bell-pepper	2.43	2.62	3.14	3.49	3.69	2.43	3.69	3.07	0.54	17.65	11.01
8.	Red- pepper	3.02	3.88	4.54	4.52	4.91	3.02	4.91	4.17	0.74	17.82	12.92
9.	Eggplants	1.98	2.84	2.45	2.77	3.46	1.98	3.46	2.70	0.54	20.14	14.97
10.	Garlic	13.49	15.57	14.59	14.69	16.43	13.49	16.43	14.95	1.11	7.40	5.05

Source: Giurgiu County Directorate of Statistics [7].

Of the crops analyzed in this study, the most significant price was recorded for garlic, which has an average price of 14.95 lei/kg, with oscillations between 13.49 lei/kg in 2016 and 16.43 lei/kg in 2020, followed by the red pepper, which recorded an average price of 4.17 lei/kg and limits between 3.02 lei/kg in 2016 and 4.91 lei/kg in 2020. the opposite pole, the vegetable crop with the lowest price was represented by potatoes, with an average of the period of 1.52 lei/kg and variations between 1.11 lei/kg in 2016 and 2.06 lei/kg in 2019. Following the analysis of statistical indicators calculated for the average annual prices of vegetables in Romania, in the analyzed period there was a standard deviation between 0.21 for white cabbage and 1.11 for garlic. Regarding the coefficient of variation, the crop with the highest degree of homogeneity of the data series was that of garlic. Autumn white cabbage crops (13.33%), field tomatoes (13.81%), capsicum (15.55%), bell pepper (17.65%), red pepper (17.82%) and eggplant (20.14%) showed a medium variation, and white cabbage (29.95%), early potatoes (26.73%) and autumn potatoes (21.77%) were the crops that recorded a large variation of the average annual price in the analyzed time interval (Table 5).

Within the program to support the production of vegetables in protected areas, out of the total amount allocated at national level, respectively 30.76 million euros, over 2 million euros will be collected during this year by the 1,011 growers in Giurgiu County (Table 6).

Table 6. List of counties with the most beneficiaries of the forms of support granted to vegetable growers in 2021- Program to support vegetable production in protected areas - top 5 counties

Nr. Crt.	*County*	*Number of beneficiaries*	*% of total beneficiaries*	*Amount due for the area (million euros)*	*% of the total amount allocated to the program (euro)*
1.	Olt	4,514	31.6	9.03	29.3
2.	Galati	3,153	22.1	6.31	20.5
3.	Dolj	1,486	10.4	2.97	9.7
4.	**Giurgiu**	**1,011**	**7.1**	**2.02**	**6.6**
5.	Buzau	660	4.6	1.32	4.3
Total the first 5 counties		10,824	75.8	21.65	70.3
TOTAL		**14,271**		**30.72**	

Source: Giurgiu County Agricultural Directorate, http://www.directiaagricolagiurgiu.eu/[7].

Thus, 6.6% of the amount allocated to the program is accessed by Giurgiu County, followed by Buzău with 4.3%, on the first place being Olt County with 29.3%. The 5 counties presented total 10,824 cultivators, representing 75.8% of the total producers at national level, and 70.3% of the amount allocated to the program is intended for these counties (Table 6).

Analyzing the data from the program to support garlic production, it is noted that out of 1,016 growers enrolled in the program, 53.8% of growers (549 producers) are from the counties of Buzau, Olt, Teleorman, Botosani and Giurgiu (Table 7).

Table 7. List of counties with the most beneficiaries of the forms of support granted to vegetable growers in 2021-Program to support garlic production - top 5 counties

Nr. Crt.	*County*	*Number of beneficiaries*	*% of total beneficiaries*	*Amount due for the area (million euros)*	*% of the total amount allocated to the program (euro)*
1.	Buzau	146	14.3	0.66	21.5
2.	Olt	140	13.7	0.38	12.2
3.	Teleorman	107	10.5	0.33	10.8
4.	Botosani	106	10.4	0.26	8.6
5.	**Giurgiu**	**50**	**4.9**	**0.18**	**5.8**
Total the first 5 counties		549	53.8	1.82	58.9
TOTAL		**1,016**		**3.08**	

Source: Giurgiu County Agricultural Directorate, http: //www.directiaagricolagiurgiu. eu / [6].

The total area cultivated with garlic being 680.4 ha, totaling approximately 59% of the total. Of the amount of 3.08 million euros, allocated under the program, 1.82 million euros are allocated to the 5 counties mentioned in the table, representing approximately 59% of the total. The amount of 0.18 million euros (5.8% of the total) was allocated for Giurgiu County, an amount that will be redistributed to the 50 beneficiaries of the program (Table 7).

CONCLUSIONS

Following the analysis of the technical indicators analyzed in this study, a potential for the development of the vegetable sector in Giurgiu County was noted. During the analyzed period, the production obtained for the main vegetables registering an increasing trend, with the exception of potato cultivation, the factor that determined the increase of productions being determined by the financial support granted within the program to support the production of vegetables in protected areas. It should be noted that although the areas cultivated with peppers and garlic have decreased, the productions recorded for these crops have increased in the period 2016-2020. At the level of 2020, in Giurgiu county the most cultivated vegetables were tomatoes (31,843 tons) and white cabbage (21,946 tons).

Regarding the average annual prices, there was an increase in recent years, the increase being accentuated by the economic crisis caused by the Covid-19 pandemic, which had a direct impact on both prices and buying habits of Romanian consumers. , in increasing numbers, they prefer to buy agri-food products through online platforms. In this context, it is necessary to develop such a platform in Giurgiu County, in order to promote and support local agricultural producers.

Currently, Giurgiu County is facing problems in maintaining the status of agricultural county, the identification of sustainable ways of socio-economic development is imperative. Among the solutions identified for the recovery of agriculture in the county are: grouping small farmers into associations and producer groups and finding alternative solutions for irrigation systems.

The poor development of the competitiveness of agricultural holdings and the lack of educational training with agricultural specifics (agricultural high schools) in Giurgiu County, prevent producers from being competitive in the market. The promotion through information and education campaigns of young farmers in accordance with the new strategies in the agricultural field is the main solution for the recovery and development of agriculture in the county.

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THE PLACE AND ROLE OF THE MANAGING AUTHORITY FOR OPERATIONAL PROGRAM FOR FISHERIES AND MARITIME AFFAIRS (AM-POPAM) IN THE ABSORPTION OF EUROPEAN FUNDS FOR THE PERIOD 2014-2020

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Abstract

This article analyzes the activity carried out by the Managing Authority for Operational Program for Fisheries and Maritime Affairs (POPAM) within the Directorate General of Fisheries (AM-POPAM) in order to ensure the information and implementation process on accessing European funds granted by POPAM for the period 2014-2020 following the concluded contracts, measures implemented , the amounts that were allocated and the gain obtained by accessing them by the applicants as a result of the existing agreements between the European Community and Romania. The actions of DGP-AM-POPAM through its decision makers at central, regional and county level ensure information and communication, in accordance with the Regulation of Organization and Functioning of the Managing Authority for POPAM and the National Strategy of the Fisheries Sector for knowledge transfer for growth competitiveness and diversification and the need to modernize the fisheries sector, by processing and marketing fish products but also by developing markets by ensuring a wide and diversified range of products and services along with the use of renewable energy while protecting the environment. The methodology used consisted in studying the bibliographic sources, collecting, processing, analyzing and interpreting the data provided by the databases of DGP and MADR, as well as formulating conclusions on the status of projects submitted, amounts allocated, achievement of targets and measures that can be taken further to support fishing and aquaculture activities.

Key words**:** *DGP-(A.M-P.O.P.A.M)***,** *projects, programmes, measures, fishing, aquaculture, EU non-refundable funds for fishing and maritime affairs*

INTRODUCTION

Given the importance of the agricultural sector in the Romanian economy, the use of European funds an opportunity for care must continue to be taken advantage of and that will help reduce the gaps between our country and the rest of the European Union [5, 6] .

The use of European funds also contributes to the efficient use of resources, the reduction of the budget deficit, the stimulation of investments, etc. [4, 7].

On 13.06.2012, the memorandum on "Approval of actions and documents on preparing to access and implement European funds in the period 2014-2020" is issued by the Government, through which the Ministry of Agriculture and Rural Development (MADR) was appointed to hold discussions with European Commission and to draw up the documents for the program financed by the European Fisheries and Maritime Fund (EMFF) on fisheries interventions. Following these negotiations, the Operational Program for Fisheries and Maritime Affairs (POPAM) 2014-2020 was elaborated and the General Directorate for Fisheries (DGP) within MADR was designated as managing authority based on the Government Decision no. 1185/2014, to coordinate this program and to collaborate with other public institutions and bodies involved.

A similar Operational Program was developed in Poland for developing the fishery and maritime sector using substantial funds from EMFF [3].

Through the elaboration of the operational program, a multitude of concrete actions were

issued:
(1)The Ministry of European Affairs approved the document "Approval of actions and documents on preparing to access and implement European funds in the period 2014-2020", in June 2012, and created a partnership between the Interinstitutional Committee for the Partnership Agreement and 12 Advisory Committees.
(2)Within the MARD, the "Consultative Committee for Rural Development, Agriculture and Fisheries" and related working groups were established, involved with specific topics.
(3)The DGP developed a socio-economic analysis of the fisheries sector on the basis of which the National Strategy for the Fisheries Sector 2014-2020 (SNSP) was prepared and approved by the Working Group.
(4)The SNSP continued the National Strategic Plan 2007-2013 through national policies and the Common Fisheries Policy (CFP). The national strategy defined the strategic goal, objectives, priorities and achievement indicators for the period 2014-2020.
(5)During the implementation period of POPAM, it was desired the cooperation with the other programs financed by FESI through the Working Group and representatives of the central public institutions with attributions in the realization of the budgets and programming for the period 2014-2020.
(6)In August 2014, a contract was signed with the objective "Technical assistance for the development and consolidation of the institutional capacity of the DGP in order to develop and prepare the implementation of POPAM 2014-2020".
(7)Through the project, the Market Study for the Romanian fisheries sector and the Multiannual National Strategic Plan for Aquaculture were elaborated.
(8)From 29.10.2014, the ex-ante evaluation team was formed. The ex-ante evaluation is required by the EC Regulation for the period 2014-2020 according to Article 55 of Regulation (EU) no. 1303/2013 and Article 116 of Regulation (EU) no. 508/2014) on the FEPAM 2014-2020 programs.
The thematic objectives are highlighted in specific priorities for each ESI fund and themes 1-4 are key themes for the ERDF, while themes 8-11 are key themes for the ESF.
The so-called thematic objectives (TOs) have the following aims:
- strengthening research, technological development and innovation;
- improving access to and increasing the quality of ICT;
- improving the competitiveness of SMEs, agriculture (in the case of the EAFRD) and the field of fisheries and aquaculture (in the case of the EMFF);
- the transition to a low-carbon economy in all areas;
- adaptation to climate change through risk prevention and management;
- conservation of environmental protection through conservation and efficient use of resources;
- promoting sustainable transport systems and removing bottlenecks in major network infrastructure;
- developing the quality of jobs and supporting the diversification of the workforce;
- promoting social inclusion and combating poverty;
- investments in education and training;
- strengthening the institutional capacity of public authorities and stakeholders and an efficient public administration.
Our country must ensure that the choice of thematic objectives responds to the needs of development and territorial challenge and ensures an integrated implementation of ESI funds.
Romania, supported by the European Commission, must implement EU investment support as efficiently as possible, coordinating ESI funds and other EU instruments, in order to manage the Common Fisheries Policy as efficiently as possible;
The Common Fisheries Policy (CFP) is a set of rules that seeks to conserve marine biological resources, manage and monitor European fisheries in and out of EU waters. The main purpose of the CFP is to strengthen fishing and aquaculture activities by providing longer-term ecological, economic and social sustainability. Promoting the common

fisheries policy to ensure the traceability, safety and quality of products sold in the EU by promoting productivity, a fair standard of living in the fisheries sector (including small-scale fishing) and a stable market. The scope of the CFP includes the protection of aquatic resources and the management of the fisheries that use them. In terms of market and financial measures, the CFP also covers freshwater biological resources and aquaculture activities, as well as the processing and sale of fishery and aquaculture products.

The current CFP is based on four pillars:

1. Fisheries management
2. International politics
3. Market and trade policy
4. Financing policy.

The fourth element of the CFP is the European Maritime, Fisheries and Aquaculture Fund (2021-2027), which helps achieve the objectives of the CFP by funding eligible actions. The CFP stipulates that sustainable fishing quotas should be established and fish stocks should be maintained for a long time. The CFP takes a prudent approach and recognizes the impact of human activities on all components of the ecosystem. The aim is to make the fishing fleet more diversified in terms of catching techniques and to reduce unwanted catches as little as possible. The CFP has changed the way fisheries policies are managed, giving the regional groups of the Member States more control by introducing so-called regionalization. The CFP is stipulated in Articles 38-43 of the Treaty on the Functioning of the European Union (TFEU). According to Article 3 TFEU, the conservation of marine biological resources is an "exclusive competence" which means that only the EU is able to legislate and adopt binding acts. Member States can only issue laws if they are empowered by the EU.

The implementation of SNSP will increase the production of fish and fish products produced domestically and will improve the quality of products in accordance with the sustainability rules of the department, thus contributing to food security and public health in Romania. At the same time, the implementation of this strategy will increase the share of the fisheries sector in GDP. In order to achieve the expected results and turn the vision of the fisheries sector into reality, the SNSP proposed the overall objective of supporting the development of a competitive, sustainable and attractive fisheries sector. The impact of SNSP will be reflected in all areas of sustainable development:

-Economic, by developing the competitiveness of the fishing sector;

-Environmental protection, by strengthening environmental services, in particular extensive aquaculture and limiting the negative effects of activities in the fisheries sector, is in particular the sustainable management of resources;

- Socially, by creating new jobs and developing social and territorial solidarity.

1. The fisheries sector is a food resource and a natural heritage

The medium to long-term economic and social importance in the field of fisheries and aquaculture has the role of developing the area through the following actions:

-Promoting competitive fishing and aquaculture, supporting economically, socially and ecologically viable producer organizations and fish farms;

-Promoting policies that are conducive to the inclusive and balanced development of the fishing area, simplifies the management and sustainable development of aquatic biological resources;

-Maritime policy assimilated to the European Union in a subsidiary manner encourages the development of a common and cohesion policy in the field of fisheries;

-The role of species aquaculture in fisheries management, as an opportunity to promote local development, creates an active economy (work in rural areas, capitalization of low-yield land) and environmental benefits or services (wetlands, biodiversity, microclimate, etc.).

The protection of the aquatic environment and the protection of the fish heritage have a universal significance for the following aspects:

-Creation and maintenance of wetlands and protection of the biodiversity of fish and birds,
-Contributing to ensuring national food security through the potential of food resources represented by aquatic biological resources at any stage of the biological cycle.

The hydrographic network of our country is 843,710 ha, representing over 3.5% of the total area of the territory. Fishing and aquaculture, along with fish processing and sales, are concerns in all parts of the country. The most valuable species of fish are 5 species of sturgeon, all threatened with extinction that we share with our neighbors Bulgaria and Serbia along the Danube but also with Turkey, Ukraine, Georgia, Russia and Bulgaria near the Black Sea.

2. Fishing

Commercial sea fishing

Romania's fishing zone is located between the Musura arm and Vama Veche on the Danube and the coastline is approximately 243 kilometers long and can be divided into two main geographical and geomorphic regions:
a) The northern region, with a total length of 158 kilometers, located between the subdelta of the Musura arm and Constanța;
b) In the south, the length between Constanța and Vama Veche is 85 kilometers.

According to the National Agency for Fisheries and Aquaculture, the main species caught in the Black Sea are small fish: mackerel, anchovy, horse mackerel. Therefore, the basis of fishing is formed by sprat, which is mainly used in the form of "salt sprat". Other species present in the catch, but in smaller numbers, are: mullet, shark, turbot and guavids

Commercial inland fishing

Commercial fishing in inland waters takes place in the natural waters that constitute the country's public domain: the Danube, the Danube Delta and the Razim-Sinoie Lagoon Complex - including the Danube Delta Biosphere Reserve, the Prut River, lakes, etc. The main inland fishing areas are the Danube Delta Biosphere Reserve and the Danube.

The species caught in inland waters are as follows: crucian carp, bream, Danube mackerel, carp, babushca, catfish, salamander.

3. Aquaculture

In the field of aquaculture, the main activity is freshwater fish farming, while the growth of other freshwater aquatic organisms (crayfish, shells, aquatic plants) or seawater almost does not exist. From a technical point of view, freshwater fish farming in Romania is characterized by two directions: intensive breeding (especially trout) and extensive and semi-intensive growing of carp in polyculture in terrestrial basins (ponds and lakes). There is not enough geographical and meteorological area for aquaculture in the Black Sea. Due to the lack of coastal relief elements that form protected areas, such as gulfs of strong winds, high waves and extreme temperatures in winter, aquaculture units in most areas of the Romanian Black Sea coast are in danger. Applicably, the only feasible alternatives for terrestrial fish farms fed by sea water are for fish (turbot) one area and four areas of farms with mollusks (mussels, oysters).

4. Fish processing

In Romania, fish processing is a traditional activity in the fishing sector. It plays an important role in the processing of fish obtained through fishing and aquaculture to use high quality raw materials to provide consumers with a wide range of fish products and through which producers bring added value. The local species commonly used for processing are: carp, blood, novac, bream, catfish, saddle, pike and trout. The most used marine species for processing are salmon, herring, sprat and mackerel. The fish is processed in several forms: decapitated, eviscerated, portioned, filleted, salted, smoked, marinated and salads.

5. Trade in fish and fish products

Imported products occupy a large share on the Romanian fishery products market. Only in recent years, several Romanian companies have begun to provide competitive products produced domestically (especially semi-prepared). Mackerel and herring are species that have a share in both import and processing. The appearance of imported species on the Romanian market determines the diversification of offers and consumer preferences for new species of fish and forms of presentation, as well as changes in the growing demand for fish and fish products.

6. Education, training and research

Due to the long-term lack of public and private sector funding and insufficient technology transfer processes, scientific research has been affected and private sector research and infrastructure are insufficient to apply research results to innovation.

The human resources involved in the research and the experience of the researchers are a huge advantage that has not been fully utilized so far.

In order to improve the level of education of all workers in the fisheries sector, it is necessary to develop vocational schools and high schools with a profile in fishing, aquaculture and fish processing [8].

MATERIALS AND METHODS

The paper is based on numerous documents of existing legislation, published reports and articles on this topic. The methods used include research of the literature, collection, processing, analysis and interpretation of data provided by the Directorate General of Fisheries (DGP) and the database of the Ministry of Agriculture and Rural Development (MADR) to implement the POPAM 2014-2020 project stage submitted. The amount allocated, the objectives achieved and the measures taken to support the fisheries and aquaculture sector by balancing fisheries management, fishery resources and the development of units to protect the fishery fund, fisheries and aquaculture.

RESULTS AND DISCUSSIONS

POPAM 2014-2020 mainly hopes to develop aquaculture production and fish processing. Other objectives include the following measures formulated by the European Union and translated into specific national objectives for the development of operators in this field, the protection and maintenance of biodiversity, the creation of employment opportunities and the protection of the environment in the fisheries sector through the following programs:

PU 1 Promoting environmentally sustainable, resource efficient, innovative, competitive and knowledge-based fishing

SO 1.1 Reducing the environmental impact of fishing, including avoiding and reducing unwanted catches as far as possible

M I.15 Limiting the impact of fishing on the marine environment and adapting fishing to the protection of species

M I.17 Protection and restoration of marine biodiversity - collection of lost fishing gear and other marine litter

SO 1.4 Increasing the competitiveness and viability of fisheries enterprises, including the small-scale coastal fleet, and improving safety or working conditions

M I.6 Income diversification and new forms of income

M I.23 Fishing ports, landing places, auction halls and shelters

M I.2 Counseling services

M I.22 Value added, quality of products and use of unwanted catches

SO 1.5 Providing support for strengthening technological development and innovation, including increasing energy efficiency, and knowledge transfer

M I.1 Innovation

M I.21 Energy efficiency and climate change mitigation - Replacement or upgrading of main or auxiliary engines

These projects aim at introducing innovative technologies for marine and / or inland fishing.

The financing of the projects was transposed through:

Providing professional advice for commercial and marketing strategies, feasibility studies and consulting services for assessing the feasibility of the project.

Provide professional advice on environmental sustainability to limit and, where possible, eliminate the negative impact of fishing activities on marine, terrestrial and freshwater ecosystems.

Promovarea dezvoltării unor activități complementare pescuitului comercial pentru creșterea și diversificarea veniturilor.

Investiții în echipamente diverse în funcție de dimensiunea sau tipul uneltelor de pescuit.

Reducea pescuitului fantomă și a poluarii habitatelor acvatice și contribuind la protecția biodiversității și a ecosistemelor acvatice prin colectarea deșeurilor marine, în special a uneltelor de pescuit pierdute sau aruncate.

Prelucrare, vânzare sau vânzare directă de către pescari.

Modernizarea infrastructurii specifice activităților de pescuit comercial și anume porturi, puncte de debarcare și a adăposturilor pescărești.

PU 2 Stimulating environmentally sustainable, resource-efficient, innovative, competitive and knowledge-based aquaculture

SO 2.2 Increasing the competitiveness and viability of enterprises in the aquaculture sector, including improving safety or working conditions, especially of SMEs

M II.2 Productive investments in aquaculture

M II.5 a Establishment of management, replacement and advisory services for aquaculture farms

M II.5 b Procurement of advisory services for aquaculture farms

M II.1 Innovation

M II.3 Productive investments in aquaculture - resource efficiency, reduction of water and chemical use, recirculation of water use minimization systems

M II.4 Productive investments in aquaculture - increasing energy efficiency, renewable energy

M II.7 Increasing the potential of aquaculture sites

SO 2.4 Promoting aquaculture with a high level of environmental protection and promoting animal health, as well as public safety and health

M II.10 Aquaculture providing environmental services

M II.12 Animal health and welfare measures

The following projects were supported:

Introduction of new categories of fish to diversify production.

Profitable investments in aquaculture, modernization of aquaculture farms, improvement of working conditions and safety of workers in the aquaculture sector, variation of aquaculture production and types of crops, diversification of income sources and development of tourism and recreation.

Increasing the profitability of farms through fishing and sports.

Surveying the most suitable areas for aquaculture or support infrastructure improvements.

Transforming traditional methods of aquaculture production into organic aquaculture.

Expenditure related to the control and elimination of diseases in the aquaculture sector, implementation of general and specific procedures for certain species or issuance of codes of conduct related to biosecurity or animal health and welfare requirements in aquaculture.

PU 3 Encourage the implementation of the CFP

SO 3.1 Improving and providing scientific knowledge and improving data collection and management

SO 3.2 Ensuring support for monitoring, control and enforcement, strengthening institutional capacity and efficiency of public administration, without increasing administrative burdens

M VI.1 Control and execution

M VI.2 Data collection

M VI.1 Control and enforcement - non-competitive appeal

The following measures were supported:

Fulfilling the commitments made by EU regulations by implementing controls and inspections on the activities of economic operators.

By creating an interoperable central database, the coordination between the scientific partners and the authorities responsible for implementing the data collection framework and improving the computerized database has been strengthened.

PU 4 Increasing employment and increasing territorial cohesion

SO 4.1 Promoting growth, social inclusion and job creation and providing support to increase employment opportunities and labor mobility in coastal and inland communities, dependent on fishing and aquaculture, including diversification

M III.1. Establishing public-private partnerships and developing strategies for integrated development of fisheries areas

M III.2 DLRC Strategies - Selection of FLAGs

The following measures have been funded:

Job creation, attracting young people and promoting innovation at all stages of the supply chain of fishery and aquaculture products.

Promoting social welfare and cultural heritage in fisheries and aquaculture.

Strengthen the role of fishing communities in local development and governance of local fisheries resources and marine activities;

Interregional or transnational cooperation and technical support;

Establishment of a public-private partnership called the Local Fisheries Action Group-FLAG and a public-private partnership without legal personality.

PU 5 Stimulation of marketing and processing

SO 5.1 Improving market organizations for fishery and aquaculture products

M IV.1 Production and marketing plans

M IV.3 Marketing measures

SO 5.2 Encourage investment in the marketing and processing sectors *M*

IV.4 Processing of fishery and aquaculture products

The following measures have been implemented:

Supports the formulation and implementation of production and marketing plans;

Establishment of producer organizations, producer associations or professional organizations;

Identify new markets and improve conditions for the placing on the market of fishery and aquaculture products;

Promote transparency in production and markets and conduct market research and research on EU import dependence;

Development of alliance eco-labels for fishery and aquaculture products, formulation of standard contracts for small and medium-sized enterprises complying with EU law and carrying out regional, national or transnational advertising and communication activities to raise public awareness of sustainable fishery products and aquaculture;

Encouraging the necessary investments for the development of the competitiveness of the economic agents from the activity of processing the fishery and aquaculture products;

Development and modernization of production capacities and favoring market access.

PU 6 Encouraging the implementation of the IMP

SO 6.1 Development and implementation of the Integrated Maritime Policy

The program was highlighted by the following actions:

Establish and manage the electronic platform needed to interconnect all parties involved in the implementation of the Marine Strategy Framework Directive, the Integrated Management System and pre-commercial procurement [10, 2].

Result indicators by PU Program

Result indicators for PU1

In order to achieve the results required by FEPAM Regulation (EU) 1014/2014, it is in principle necessary to complete the operation and perform one or more production cycles, which means a contract lasting several years from the signing of the contract.

The MA procedure provides for the verification of the values of the monitoring results indicator in the last year.

The first contracts have been signed since the year and the results of the verification have not yet been obtained for reporting.

Jobs created – 16

Jobs maintained -66

Table 1. Result indicators for PU1

Process	**Period 2014-2020**	
	PU1	
	OS 1.4	
	M I.23	M I.22
Applications	10	3
Contracts	8	2
Contract value (Euro)	2,894,853	128,207
Payments made (Euro)	944,620	128,207

Source: Own format.

Identified problems and measures to solve

In 2017, at a meeting of the Monitoring Committee, representatives of fishermen from the Danube Delta expressed interest in obtaining compensation, such as compensation for the temporary suspension of fishing activities.

Local public authorities have a low interest in port fishing infrastructure, as only the modernization of existing infrastructure can obtain funding, and cannot set up new fishing ports, landing places or auction centers.

In this case, private beneficiaries, ie commercial fishermen, do not have sufficient income to support such investments (their income is limited to the fishing quota allocated to the fishing authorization) and the co-financing quota is 50%.

In this case, private beneficiaries, ie commercial fishermen, do not have sufficient income to support such investments (their income is limited to the fishing quota allocated to the fishing authorization) and the co-financing quota is 50%.

In the context of the COVID-19 pandemic, the POPAM will be reviewed at the end of 2020, and measures I.9 Article 33 and Article 44 (4a) will be temporarily suspended to compensate economic operators in the fisheries sector for the losses suffered, and 2,000,000 euros will be allocated to this area.

It also created the possibility for the beneficiary to suspend the execution of the contract for two months.

In view of the extremely low requests, DGP-AMPOPAM decided to cancel these measures and redistribute the relevant amount to measure I.23.

Result indicators for PU2

The results are obtained after several production periods and after a few years from the signing of the contracts. In order to obtain the results, as established for FEPAM by Regulation (EU) 1014/2014, it is necessary, in principle, to complete the operation and carry out one or more production cycles, which means a period of several years from the signing of the contract. financing. The Managing Authority validates the values resulting from the last year of monitoring, except for measure 11.10, where the values will be validated at the end of contracts. The first contracts were signed starting with 2016 and the validated results were included only in measure 11.10.

The volume of aquaculture production had the following values: 6,374.58 tons by 77.83% less than the proposed target of 8,190 tons;

The variation of the production volume with recirculation system was 95.1 with 36.44% less than the proposed target of 261.

Aquaculture farms that deliver environmental services: they represented 67.74 with 63% less than the target of 67.

Table 2. Result indicators for PU2

Period 2014-2020				
Process				
PU2	Applications	Contracts	Contract value (Euro)	Payments made (Euro)
OS 2.2.				
M II.2	213	93	68,019,528	20,379,127
M II.5	10	5	630,026	600,023
M II.3	10	3	802,432	566,762
M II.4	6	2	132,026	132,026
OS 2.4.				
M II.10	112	45	24,280,059	24,280,059
M II.12	4	3	241,503	121,821

Source: Own format.

Identified problems and measures to solve:

-private beneficiaries do not have enough income to support such investments, and the co-financing rate is 50%.

- during the meeting with the potential beneficiaries, the convenience created for the payment of the invoice and the advance payment of the free financial support of up to 50% was introduced.

In 2019, the implementation strategy of POPAM and the financial allocation related to its measures were reconsidered, as well as the reallocation of performance reserves. The standard used is the level of demand for the relevant measures in 2019. II.9 (Article 53), but no application for funding has been submitted. Due to lack of interest, DGP-AMPOPAM decided to cancel these measures. The value of the result indicator assumed by ANPA at the end of the implementation of the selected project is the value provided in POPAM 2014-2020.

During the Covid-19 pandemic, POPAM introduced measure 11.11 called Public Health Measures, which introduced compensations for economic operators in the field of aquaculture and issued calls for applications for funding. This measure is still in force. This measure also introduced the possibility for beneficiaries to suspend the execution of contracts for a period of 2 months. The Managing Authority has regulated the over-contracting of investments and the possibility to simulate simple acquisitions in calls for contributions to aquaculture leading to increased absorption.

Result indicators for PU3

The values of the indicators resulting at the end of the implemented projects are those assumed by the National Agency for Fisheries and Aquaculture and provided in POPAM 2014-2020.

Table 3. Result indicators for PU3

Process	**Period 2014-2020**	
	PU 3	
	OS 3.2	
	M VI.1	M VI.2
Applications	5	1
Contracts	2	1
Contract value (Euro)	3,753,693	2,484,866
Payments made (Euro)	2,320,790	2,484,866

Source: Own format.

Result indicators for PU4

The managing authority applies the procedure by which it validates the values of the result indicators at the end of each monitoring year. Validated results did not start to appear because the first contracts for this program were signed in 2018.
Jobs created – 16
Jobs maintained -66

Table 4. Result indicators for PU4

Process	**Period 2014-2020**	
	PU 4	
	OS 4.1	
	M III.1	M III.2
Applications	48	272
Contracts	28	266
Contract value (Euro)	490,728	99,510,615
Payments made (Euro)	490,728	14,186,973

Source: Own format.

Identified problems and measures to solve:
The requests in 2020 have doubled compared to 2019 for this program. With the Covid-19 pandemic, the acquisitions of the beneficiaries were affected due to the lack of bidders or due to non-compliant offers or products from late import construction works by reducing them during emergencies and national alert. Environmental permits were maintained but could not be implemented.
The implementation of the contracts whose objective was the organization of festivals was affected due to the restrictions imposed during the states of emergency and alert. The beneficiaries had the possibility to suspend the execution of the contracts for a period of 2 months and in case of termination of the contracts, FLAG has the possibility to open new sessions for the value of the terminated contracts.

Result indicators for PU5

Regulation (EU) 1014/2014, provides that for the issuance of the results of the program, as mentioned in the EMFF, it is necessary, the completion of the operation and the development over several years of production, from the signing of the financing contract. The resulting indicators are valid only in the last year of monitoring. The first contracts were signed in 2016 and no data were reported. Implementation of projects for OS 5.2. it went like this: Change in the sales value of entities that are not producer organizations to 19,926.72 units, with an increase of 773.55% of the proposed target of 2,576.00;
Modification of the sales volume of non-producing entities to 2,848.81 units with an increase of 406.97% compared to the proposed target of 700.00.

Table 5. Result indicators for PU5

Process	**Period 2014-2020**
	PU 5
	OS 5.2
	M IV.4
Applications	25
Contracts	18
Contract value (Euro)	10,264,073
Payments made (Euro)	6,897,232

Source: Own format.

Identified problems and measures to solve:
During the COVID-19 pandemic, POPAM was modified by supplements intended for measure IV.4, by granting compensation for damages caused to economic operators in the field of fish processing.

Result indicators for PU6

Identified problems and measures to solve:
Among the EU-27 Member States, Romania has the largest diverse biogeographical area (5 out of 11 European biogeographical regions), which is mainly in a favorable state of conservation. In order to ensure special measures for the protection and conservation of natural heritage assets "in situ", differentiated systems of protection, maintenance and use have been established on the following categories of nature reserves specified in the Statistical Yearbook 2008 and INS - 2011 data and has the following characteristics**:**

It is of national interest,

a) 64 scientific reservations occupying an area of 218,145 ha;

b) 13 national parks occupying an area of 316,872 ha;

c) 206 natural monuments occupying an area of 15,406 ha;

d) 699 nature reserves occupying an area of 346,933 ha;

e) 15 natural parks occupying an area of 772,810 ha;

f) 148 special avifauna protection areas occupying an area of 3,694,394 ha;

g) 383 sites of Community importance occupying an area of 4,152,153 ha,

h) biosphere reserves, designated on the basis of the criteria established by the MAB/ UNESCO - 3 Committee occupying an area of 664,446 ha: Delta

i) 19 wetlands of international importance, designated on the basis of the criteria established by the Secretariat of the Ramsar Convention occupying an area of 1,156,448 ha

j) World Natural and Cultural Heritage Sites, designated on the basis of criteria established by the Paris Convention

k) Danube Delta (1991), occupying an area of 580,000 ha [1, 9].

Table 6. Result indicators for PU6

Process	**Period 2014-2020**
	PU 6
	OS 6
Applications	1
Contracts	1
Contract value (Euro)	2,389,865
Payments made (Euro)	584,601

Source: Own format.

Table 7. Result indicators for technical support

Process	**Period 2014-2020**
	Technical support
Applications	10
Contracts	10
Contract value (Euro)	16,779,992
Payments made (Euro)	13,846,532

Source: Own format.

CONCLUSIONS

Protecting the fishery heritage means the balanced management of fishing activities with fishery resources as the main element and the sustainable management of aquaculture units. Given that these activities have social and economic characteristics, ownership is stable and industry is developing. Until 2005, the structure of Romania's fish production was dominated by cyprinids, which came from the European continent and Asia, representing 85% of the total, and the remaining 15% consist of trout, pikeperch, pike, perch, catfish, sturgeon, etc. Romanian aquaculture must be in line with European aquaculture. European aquaculture has a high level of technology and environmental sustainability and offers high quality fish. The production meets the highest standards of animal health and consumer protection. It has an advantage and is the main competition for aquaculture in the EU. At the same time, Romanian aquaculture must promote its specific characteristics and bring it closer to sustainable conditions through the type of technology used (extensive and semi-intensive growth of polyculture).

The problems reported by the beneficiaries can be divided into two categories:

⊗ With regard to the activities of the managing authority, the necessary opinions are not clearly specified;
-Complex procedures and long settlement or repayment time;
-The guide is not easy to understand;
-Evaluation and subjective selection;
-Different opinions on similar cases;
- Late payment;
-Long time between approval and signing of the contract and long time for reimbursement of expenses.
-The funding application is completed with data irrelevant for the project submission stage;
-The need for cost criteria to avoid unjustified repetitive auctions.
-The deadline for submitting technical projects is too short, the designers are inconsistent and the builders are missing.
⊗ With regard to the activities of the managing authority, the necessary opinions are not clearly specified;
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-The guide is not easy to understand;
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-The deadline for submitting technical projects is too short, the designers are inconsistent and the builders are missing.

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PASTORAL, IMPERATIVE ARRANGEMENT OF THE SUSTAINABILITY OF PRACTICAL ECOSYSTEMS

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Abstract

This research is based on the need to ensure adequate quantitative and qualitative feed in the context of population growth, climate change and the need to protect the environment. The research is characterized by topicality and complexity, highlighting a series of elements meant to ensure the sustainability and multifunctionality of the meadows through a sustainable management of the grass carpet and the resources involved. The research highlights the role of legislative measures in creating a relevant technical, organizational and economic framework, but also takes into account the characteristics of the meadow, respectively human activity. The research methodology used is the case study, due to its adaptability to territorial specificity and is based on the diagnosis of the grassland ecosystem researched using the gravimetric method. The diagnosis of the researched grassland ecosystem highlights a vulnerable state of them that requires the development of special management plans that contain specific measures of care, maintenance and recovery. In essence, the research highlights the particularities of setting up a pastoral arrangement in the commune of Arpașu de Jos, in Sibiu County.

Key words**:** *grass carpet, meadow, management, pastoral value, settlement,*

INTRODUCTION

The notion of meadow is defined by different authors in different ways, with a narrower or broader meaning. It is generally accepted that grasslands are "an area of land occupied by grassy vegetation" [10], made up of "species of grassy (plants belonging to several botanical families" [2], which from the point of view of the ecological-physiognomic classification, they are part of the category of "terrestrial herbaceous communities" [3]. The meadow represents the renewable biological resource from which the most efficient and valuable fodder for animal breeding is obtained [5]. Also, the meadow fulfills an important multifunctional ecological and social economic role, offering at the same time favorable support for the coexistence of various habitats and species [12]. Romania has a generous pastoral heritage valued at an area exceeding 4.8 million hectares. The literature indicates that the practical ecosystem is strongly influenced by a number of factors of natural and anthropogenic origin whose meaning has been negative in recent decades [11]. It is known that the renewable biological productions within the practical ecosystems as well as the diversity of the plants that make up the grass carpet are different from one location to another mainly due to the differences in the availability of resources and the way of capitalization. Thus, measures are needed to promote a sustainable management of practical ecosystems in order to obtain higher production and better quality in terms of preserving and / or improving the biodiversity of species, respectively environmental protection [9]. In order to support this initiative, the responsible factors adopt a set of measures, including legislative ones meant to favor from a technical, organizational and economic point of view a framework that ensures the sustainability of the multifunctional of the meadows. It is defined by Government Emergency Ordinance no. 34/2013 and the implementing rules approved by H.G. 1064/2013, normative acts that subsequently underwent several amendments [4]. By elaborating these norms, the Romanian legislator wanted to clearly establish the organization, administration and exploitation of pastures and hayfields. In this context, the purpose of this research is to regulate in time and space the rational and efficient use of grassland production in Arpașu de Jos commune, Sibiu county by developing special management plans containing specific measures of care, maintenance and recovery.

MATERIALS AND METHODS

The methodology for drawing up the pastoral arrangement is the one provided in the Guide for drawing up the pastoral arrangements, elaborated by the Research - Development Institute for Meadows, Brașov, and in the legislation in the field [7] (GEO no. 34/2013 on the organization, administration and operation of permanent meadows and for the amendment and completion of the Land Fund Law No. 18/1991, with subsequent approvals and amendments).

The purpose of the research derives from the purpose of pastoral arrangement and refers to the regulation in time and space of rational and efficient capitalization of meadow productions in Arpașu de Jos commune, Sibiu county (geographically identified by the following coordinates: parallel 45°46'41' 'northern latitude and meridian of 24°37'24' 'east longitude), taking into account seasonal conditions, available resources, agri-environmental measures, the improvement and maintenance of biodiversity and environmental protection.

Sustainable recovery of grasslands is a major problem that many specialists adhere to [6] and requires the development of special management plans that contain specific measures of care and maintenance, timely harvesting of hayfields, use rational use of pastures as grazing time, animal loading, traffic, etc. [8].

The objectives are represented by the identification and characterization of the meadows belonging to the territorial administrative unit, the study of their characteristics, as well as the elaboration of a relevant documentation for the planning of the activities specific to the achievement of the proposed purpose.

RESULTS AND DISCUSSIONS

The present research has as object of study the quality of the grassy carpet of the meadows located in the southeast of Sibiu county at an altitude of 540 m and under the administration of Arpașu de Jos commune. It is 47 km from Sibiu and 15 km from Victoria on the road that connects Sibiu with Brasov. These meadows have an area of 5096.55 ha, are tabulated since 2003 and have the following categories of use (Table 1):

Table 1. Meadows and categories of use

Grasslands belonging to the administrative point of view of Arpașu de Jos commune (ha)	Pasture (ha)	Grassland (ha)	No productive purposes (ha)	Total
	3,160.25	1,803.45	132.44	5,096.55

Source: Sibiu County Agricultural Directorate.

The present research is characterized by addressing the specific elements of the technical, organizational and economic framework conducive to ensuring the sustainability of the multifunctional character of meadows by conducting a case study that includes both the category of pasture use area of 9.18 ha located in plot 5 locally called "Gropanele (5) ”as well as the category of hay use in an area of 34.19 ha located in plots 5,6,7 locally called“ Gropanele (5,7) ”and“ În Făget (6) ”.

The researched meadow presents a set of characteristics that particularize the specific activities starting from the exploitation mode. The meadow exploited by grazing is located in Noul Român in a single plot (Pș 236/1) at an altitude between 420-475 m, exposure S, SE, inclination from 5-35^{O} on two types of soil (calcareous regosol, respectively typical faeozium). The meadow exploited as hay is located in Noul Român in several plots: Fn 162, Fn 164, FN 166 in the field called locally “In Făget (6)” and Fn 173, Fn 206, Fn 215, Fn 217, Fn 219, Fn 157, Fn 222/1, Fn 223, Fn 231, Fn 244, Fn 246, Fn 249, Fn 256/1 in the field locally called “Gropanele (5,7)” at an altitude between 410-460 m, exhibition S, SE, inclination from 5-35^0 on three soil types (calcareous regosol, entic-calcareous alluvial, respectively stegnogleized luvosol). Soil drainage is diversified from very weak to gleiosols, to weak-imperfect to most identified soil types, respectively moderately-good to alluvial soils. The territory on which the researched meadow is located is part of the temperate-continental climate, influenced by ocean air masses. The annual temperature range is 21-24 ° C, and the maximum annual rainfall is 1,000-1,300 mm. The studied meadow belongs from a geobotanical point of view in the immoral area and belongs to the undergrowth of sessile oak and sessile oak forests. The plant species that make up the grassy carpet attest that the meadow belongs to the series and implicitly to the type *Agrostis tenuis sibth - Festuca rupicola heuff*. The floristic relief of the studied meadow is different depending on the location and the mode of exploitation. For the meadow exploited by grazing, the following composition is highlighted: *Festuca rupicola H* (15%), *Agrostis tenuis S*. (11%), *Festuca rubra L*. (5%), *Cynosurus cristatus L*. (5%), *Festuca ovina ssp. Sudetica K*. (3%), *Agropyron repens L*. (2%), *Dactylis glomerata L*. (2%), *Briza media L*. (1%), *Chrysopogon grillus L*. (1%), *Trifolium repens L* (9%), *Trifolium pretense L* (4%), *Medicago sativa L* (3%), *Lotus corniculatus L* (2%), *Achillea millefolium L* (2%), *Thymus serpyllum L* (2%), *Plantago major L* (2%), *Rhinanthus minor L* (1%), *Cichorum intybus L* (1%), *Mentha longifolia L* (1%), *Equisetum arvense L* (1%). At the same time, a degree of vegetation cover of 73% and the presence of woody vegetation was identified, accompanied by the degradation of the grass carpet on an area of 27%. The identified invasive wood species are: *Carpinus betulus L* (8%), *Crataegus monogyna J*. (6%), *Prunus spinosa L*. (5%), *Rosa canina L*. (4%), *Corylus avelana L*. (3%), *Sambucus nigra L*. (2%). In the meadow exploited by hay, the following composition is highlighted: *Festuca rupicola H*. (12%), *Festuca valesiaca S*. (9%), *Festuca pratensis H*. (7%), *Agrostis tenuis S*. (6%), *Holcus lanatus L*. (3%), *Dactylis glomerata* L (2%), *Briza media L*. (2%), *Chrysopogon grillus L*. (1%), *Trifolium repens L* (4%), *Trifolium pretense L* (3%), *Medicago sativa L* (4%), *Lotus corniculatus L* (2%), *Achillea millefolium L* (2%), *Thymus serpyllum L* (2%), *Plantago major L* (2%), *Rhinanthus minor L* (1%), *Cichorum intybus L* (1%) %), *Mentha longifolia L* (1%), *Prunella speciens L* (1%). At the same time, a degree of vegetation cover of 65% and the presence of woody vegetation accompanied by the degradation of the grassy carpet on an area of 35% were identified. The identified invasive wood species are: *Carpinus betulus L* (9%), *Crataegus monogyna J*. (7%), *Prunus spinosa L*. (6%), *Rosa canina L*. (6%), *Corylus avelana L*. (4%), *Sambucus nigra L*. (3%), *Robinia pseudoacacia L*. (2%).

Table 2. Calculation of the pastoral value of the meadow in an area of 9.18 ha located in plot 5 locally called "Gropanele (5.7)" and "in Făget (6)" category of pasture use

Species	%PC	IC	PC*IC
Poaceae	***45***		
Festuca rupicola H.	15	2	30
Agrostis tenuis S.	11	3	33
Festuca rubra L.	5	3	15
Cynosurus cristatus	5	3	15
Festuca ovina ssp. sudetica K.	3	1	3
Agropyron repens L.	2	2	4
Dactylis glomerata L.	2	5	10
Briza media L.	1	1	1
Chrysopogon grillus L.	1	0	0
Fabaceae	***18***		
Trifolium repens L	9	5	45
Trifolium pretense L	4	5	20
Medicago sativa L	3	5	15
Lotus corniculatus L	2	4	8
Other families	***10***		
Achillea millefolium L	2	2	4
Thymus serpyllum L	2	1	2
Plantago major L	2	2	4
Rhinanthus minor L	1	0	0
Cichorum intybus L	1	1	1
Mentha longifolia L	1	0	0
Equisetum arvense L	1	0	0
Wooden species	***27***		
Carpinus betulus L	7	0	0
Crataegus monogyna J.	6	0	0
Prunus spinosa L.	5	0	0
Rosa canina L.	4	0	0
Corylus avelana L.	3	0	0
Sambucus nigra L.	2	0	0
TOTAL	100	x	210
Pastoral value	x	x	42
Assessment of VP	**Medium-Good**		

Source: own processing.

The identification of the plants that make up the grassy carpet of the studied meadows, allowed using the gravitational method the appreciation of the pastoral value (Table 2).

For this, areas of 1 sqm were delimited, from which the plants and their weight by weighing were identified. The results obtained were used to determine the pastoral value using the formula VP = ∑PC (%) * IC / 5.

Table 3. Calculation of the pastoral value of the meadow in an area of 34.19 ha located in plots 5,6,7 locally called "Gropanele (5)" category of pasture use

Species	%PC	IC	PC*IC
Poaceae	***42***		
Festuca rupicola H.	12	2	24
Festuca valesiaca S.	9	2	18
Festuca pratensis H.	7	5	35
Agrostis tenuis S.	6	3	18
Holcus lanatus L.	3	2	6
Dactylis glomerata L	2	5	10
Briza media L.	2	1	2
Chrysopogon grillus L.	1	0	0
Festuca rupicola H.	***13***		
Festuca valesiaca S.	4	5	20
Fabaceae	3	5	15
Trifolium repens L	4	5	20
Trifolium pretense L	2	4	8
Medicago sativa L	***10***		
Lotus corniculatus L	2	2	4
Other families	2	1	2
Achillea millefolium L	2	2	4
Thymus serpyllum L	1	0	0
Plantago major L	1	1	1
Rhinanthus minor L	1	0	0
Cichorum intybus L	1	0	0
Mentha longifolia L	***35***		
Prunella speciens L	8	0	0
Wooden species	7	0	0
Carpinus betulus L	6	0	0
Crataegus monogyna J.	5	0	0
Prunus spinosa L.	4	0	0
Rosa canina L.	3	0	0
Corylus avelana L.	2		
Sambucus nigra L.	100	X	187
Robinia pseudoaccacia L.	x	X	37,4
TOTAL	***42***		
Pastoral value	12	2	24
Assessment of VP	**Medium**		

Source: own processing.

After assessing the pastoral value, the animal load was calculated. For this it was necessary to know the total grass production (Pt) and to establish the grass utilization coefficient (Cf). The total production was obtained by weighing the grass carpet harvested from areas of 2 sqm delimited for this purpose. It totaled 9,000 kg. green table per ha. The calculation of the utilization coefficient required the establishment of the unconsumed residues (Rn) by mowing and weighing them on surfaces of 10 sqm. The value of 2000 kg / ha was thus obtained. Both the value of the total production and the value of the unconsumed residues were used to calculate the utilization coefficient of the grass using the formula: Cf (%) = [(Pt (kg / ha) - Rn (kg / ha) / Pt (kg / ha)] * 100 and the value Cf (%) = [(9000-2000) / 9000] * 100 = 77.78. The determination of the pasture load taking into account the daily grass requirement per animal, in our case dairy cows (Nz) and the number of days of grazing (Zp) was done using the formula Ip (head / ha) = Pt * Cf /Nz * Zp * 100 and recorded the value of Ip = 9,000 * 77,378/65 * 160 * 100 = 0.67 cows per ha (UVM/ha) The data obtained allow the calculation of the load total pasture (IAP) as the product between pasture area (ha) and pasture load (Ip), so IAP = 9.18 * 0.67 = 6.15 head no. (UVM) Similar production values were obtained and The analyzed meadow did not benefit from amelioration works, which makes it possible that by applying specific improvement measures as well as by promoting a rational capitalization, the grazing capacity will increase by improving the coefficient. and use according to the literature [11] which leads to a pasture load of over 1.5 LU/ha, respectively to a total pasture load of at least 13.78 cows (LU). The obtained results, respectively the average / medium to good quality of the studied meadows, highlight the lack of elaboration and implementation of some improvement measures. They represent the object of pastoral arrangement and lead to the implementation of a management relevant to obtaining an integrated management by coordinating the factors of production and ensuring the sustainability of renewable biological productions [5].

The measures to improve the analyzed meadow are the object of the arrangement established for this purpose and include a set of technical-cultural works adapted to the specifics of the meadow, respectively to the climatic conditions in accordance with the legislation, agri-environmental measures and good practices. The main proposed works aim at: the removal of the woody vegetation with the maintenance for the protection against erosion of the solitary or grouped trees for shade; removal of plants that harm the quality of animal production, respectively animal health, stop land deforestation; improving biodiversity and pastoral value; promoting the sustainable use of renewable organic production; equipping the lawn with drinkers, etc. Also, the improvement of the quality of the grass carpet as a result of the increase of the percentage of leguminous plants as an effect of the applied measures contributes to the increase of the soil fertility [1].

CONCLUSIONS

The research highlights a number of elements designed to ensure the sustainability and multifunctionality of grasslands through a sustainable management of the grass carpet and the resources involved.

The research highlights the role of legislative measures in creating a relevant technical, organizational and economic framework, but also takes into account the characteristics of the meadow, respectively human activity.

The research highlights the particularities of setting up a pastoral arrangement in Arpașu de Jos commune, Sibiu county and is based on the fact that renewable biological productions within practical ecosystems and the diversity of plants that make up the grass carpet are different from one location to another mainly due to differences in availability of resources and how to capitalize.

The plant species that make up the grassy carpet attest that the meadow belongs to the series and implicitly to the type Agrostis tenuis sibth - Festuca rupicola heuff. The floristic relief of the studied meadow is different depending on the location and the mode of exploitation.

The description of the analyzed meadow vegetation and the appreciation of the pastoral value as a means to good requires the application of improvement works that are the object of the arrangement constituted for this purpose and include a set of technical-cultural works adapted to the specifics of the meadow. good practices.

The application of specific improvement measures as well as the promotion of a rational capitalization lead to the increase of the grazing capacity by improving the utilization coefficient, respectively to the increase of the pasture load from 0.67 to over 1.5 LU/ha.

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MANAGEMENT OF THE ACTIVITY OF LEASE AND CONCESSION OF LANDS WITH AGRICULTURAL DESTINATION BELONGING TO THE PUBLIC AND PRIVATE DOMAIN OF THE STATE WITHIN SIBIU COUNTY, ROMANIA

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Abstract

This paper analyzes a topical issue, namely the lease and concession of agricultural land belonging to the public and private domain of the state, with the pointing of the particularities of land allocation in the case study, conducted in Sibiu County. It is an extensive study based on important opinions expressed by the literature and statistical data provided by the National Institute of Statistics in Romania. Specifically, the scientific research undertaken aimed at studying historically and comparatively the evolution of leasing and concession contracts in our country. It highlights the steps to be followed to become a contractual partner of the two types of contracts, the procedure for carrying out and pursuing these contracts by the State Domains Agency both at national and local level. The methodology used is the case study and is based on the secondary analysis of statistical data and relevant literature. In essence, the study highlights a set of elements with a role in highlighting the most common categories of rented and leased use, efficient management of state-owned agricultural land, improving soil quality, increasing revenues to the state budget.

Key words**:** *lease, concession, management, ground, meadow*

INTRODUCTION

The notion of public domain is not a relatively new notion, it has been used over time by great doctrinaires and scientists in various scientific works and has acquired several connotations [1]. From ancient times, there was a need to extract from the rules of private law, certain categories of goods, which were intended for use by the whole community, were to be subject to special rules. These goods, seen as of great importance for social interests, were subject to limitations over time, so as not to be diverted from the purposes they served, forming the public domain. In the literature, it has been argued that "public domain goods are subject to an exorbitant legal regime, derogating from common law" [7]. According to another opinion, the reason behind the imperative of the existence of specific statutes, derogating from the common law, in the matter of these goods is represented by the general public interest, which the administration must realize [1]. Any society that has reached a certain stage of organization must recognize both the goods that belong to each individual and those goods that belong to the community. Precisely for this reason, two categories of goods were highlighted. A first category consisted of goods similar to those owned by individuals and over which the public authority exercises the same rights as them, forming the private domain. A second category consisted of goods considered of greater importance for social interests, goods that were subject to restrictions, in order to prevent their diversion from the purposes they serve, forming the public domain. With the adoption of the 1991 law, the provisions on the public domain were reintroduced into Romanian legislation. Although the object of this law is given by the lands, the same law provides that they may belong to the public domain. Public lands refer to those lands that are subject to public use. The inalienable character of the public property, attests the fact that the goods that make up the public property are not in the civil circuit. As a result, such land or property may not be passed on to others during their lifetime or by will or bequeathed after their death. The dismantling of property rights is also prohibited. So, the inalienable nature of the public property right means the prohibition of alienation of assets that make up this property by legal acts of private law, but also the impossibility of acquiring such assets by foreigners, by any means established by law [2]. Failure to comply with this prohibition will result in the sanction of absolute nullity. The right to property is imperceptible. This legal character of the public property right is a consequence of the inalienability of this property and consists in the impossibility of pursuing the public property goods by the creditors in order to realize their claims. At the same time, the "impossibility of constituting real guarantees on these goods is highlighted [11]". "The right of public property is imprescriptible, as it results from the provisions contained in article 861 paragraph 2 of the Civil Code". "It follows that ownership of public lands does not cease to be unused". "Also, the provisions on usufruct are not applicable in the present case[8]". Private property is guaranteed and protected by the constitution, as it results from the provisions of art. 44 paragraph 1 of the Constitution, which stipulates that: "the right to private property, as well as claims against the state are guaranteed", as well as art. 44 para. 2 of the Constitution according to which [5].: "private property is protected and guaranteed equally by law, regardless of the owner" [12]. As we well know, the other main real rights have been regulated on the basis of the right of property, private or public, and here I refer to the right of usufruct, use, habitation, surface, the right of administration, concession or free use. In agriculture, taking into account the fact that the main means of production is the land, we find ourselves in the presence of a type of land ownership, which highlights the right of possession, use, disposition, management and usufruct of a land area by own power and interest own [10]. So we are talking about two forms of land ownership: private property and public property. The first form of ownership includes the amalgam of land belonging to individuals, legal entities or the state. The private domain of the state includes those lands that are found or have become its property. Within the property under public law we will find those lands that are of national or local use or interest. The lands found in state property that remained after all restitution applications were exhausted are divided into two distinct categories - the public domain of the state and the private domain of the state. The public domain areas of the state are of special interest and use. As such, they cannot be sold or exchanged, but can be leased or concession. Agricultural areas, which are part of the private domain of the state, represent the residual land that belongs to the state, but is not classified as part of the public domain. Therefore, the mentioned land can be sold, leased or concession. Part of this private state land belongs to villages, towns, municipalities and counties and is allocated to cover local needs and uses. However, another part is found in the administration of the State Domains Agency and is generally leased to farmers. Leasing the land is also a way of manifesting private property over the land, through which a certain area of land found in the property is given for temporary use by the owner, a natural or legal person called the lessee. It should be noted that the lessee must have specialized studies or agricultural practice [10]. According to art. 1836 of the Civil Code, the following goods fall under the lease: agricultural lands and animals, constructions of any kind, machines, equipment and other such goods intended for agricultural exploitation. In this case, it is interesting to rent agricultural goods, because, at present, there is a growing interest in renting such land by Romanians.

This study aims to efficiently manage land under state management through the method of leasing and/or concession by meeting the following objectives: highlighting the categories of use most often leased and / or leased, maintaining balance and improving soil quality, state assets, management efficient use of leased and leased agricultural land,

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.realization of the objectives of programs established at national level within agricultural land.

MATERIALS AND METHODS

The study was conducted in Sibiu County located in central Romania between 45°28'-46°17' north latitude and 23°35 '- 24°57' east longitude which has a total area of 5433 km2 which represents 2.3% of the country. The State Domains Agency manages in Sibiu county agricultural and non-agricultural lands from the public and private domain in a total area of 17,254.48 hectares, of which 483.79 hectares represent the public domain area, and the surface of 16,770.69 hectares is represented by the private domain. This research contains elements that attest to the complexity and timeliness of the issue addressed, which led to the adoption of the case study as a research methodology [6]. The relevance of choosing the case study consists in the ability to correctly highlight complex situations, to allow the shaping of clear images of the highlighted problems and to identify the causes that generated them [4]. The research is a descriptive and explanatory study on the management of concession and lease of agricultural land found in the state, based on the most important opinions expressed by the literature and statistical data provided by the National Institute of Statistics in Romania. Specifically, the scientific research undertaken aims to study from a historical and comparative point of view, the evolution of leasing and concession contracts in our country.

The purpose of this research is the efficient administration of agricultural land under state management, through the method of concession and lease, within Sibiu County.

The main interest is the administration, respectively the proper management of the agricultural lands that are found in the private or public property of the state by the beneficiaries of the lease and concession contracts.

RESULTS AND DISCUSSIONS

In Romania, the land groups 10 categories of use, among which we distinguish 5 categories of agricultural land and 5 non-agricultural categories, each having in turn subcategories of use [3]. The five categories of agricultural use: arable land, pastures, hayfields, vineyards and orchards are also found in the private or public management of the state. These are defined by a set of specific characteristics, by surfaces that oscillated in a positive and negative direction after 1990 requiring an update [9] and present in 2018 the following expression: (Table 1 and Table 2).

Table 1. “Categories of agricultural land use in the public domain of the state and the ATU (2018)”

“Indicators”	**“Public domain belonging to the state (ha)”**	**“Public property belonging to ATU (ha)”**	**“Total (ha)”**
Arable land	1,337	214	1,591
Pasture	3,447	3,880	7,327
Grassland	993	137	1,130
Vine	55	2	57
Orchards	619	10	629
Total	6,491	4,243	10,734

Source: Sibiu County Agricultural Directorate

Table 2. Categories of agricultural land use in the private domain of the state and the ATU (2018)

Indicators	**State-owned private property (ha)**	**Private property belonging to ATU (ha)**	**Total (ha)**
Arable land	3,401	3,432	6,833
Pasture	3,518	71,486	75,004
Grassland	2,218	2,440	4,658
Vine	1,369	20	1,389
Orchards	1,947	0	1,947
Total	12,453	77,378	89,831

Source: Sibiu County Agricultural Directorate.

The analysis of the data in Tables 1 and 2 highlights the relevance and the large share held by the categories of pasture and hay use. Thus, the total area of these categories of use is 4,440 hectares in public property belonging to the state, respectively 5,736 hectares in private property belonging to the state, respectively 4,017 hectares in public property belonging to territorial administrative units and 73,926 hectares found in private property of territorial administrative units.

The secondary analysis of the relevant data obtained from the literature and statistical sources shows that in 2020 in the administration of the State Domains Agency in Sibiu County, there are productive agricultural areas in the public domain of the state totaling 429.29 hectares of land, of which the largest the surface is occupied by orchards and arable land (Table 3).

Table 3. Situation of agricultural land areas under the administration of A.D.S.

County	Domain type	Arable land (ha)	Pasture (ha)	Grass-land (ha)	Vine (ha)	Orchards (ha)	Total (ha)
Sibiu	Land in the public domain	116.18	17.85	48.79	63.96	182.51	429.29
	Private land	3,365.10	4,220.57	2,847.62	1,417.49	2,012.97	13,863.75
	Total	3,481.28	4,238.42	2,896.41	1,481.45	2,195.48	14,293.04

Source: own processing.

In the same period, according to official data, in the private domain of the state there is an area of 13,863.75 hectares, where the largest share is recorded by pastures, followed by arable land and hayfields. The analysis of the statistical data presented in Table 3 shows that in the public and private domain of the state, as areas under the management of ADS, there are 3,481.28 hectares of arable land, 4,238.42 hectares of pastures, 2,896.41 hectares of hayfields, 1,481.45 hectares of vineyards and 2,195.48 hectares of orchards. From this total we can observe that the surface representing the meadows under the administration of A.D.S. Amounts to a total of 7,134.83 hectares. The lands under the administration of the State Domains Agency in Sibiu County, represent an important agricultural resource to which many entrepreneurs show a special interest, so that by 2020 most areas are contracted by individuals and legal entities, as can be seen in the Table 4.

Table 4. The situation of the contracted agricultural land areas under the administration of A.D.S.

County	Domain type	Arable land (ha)	Pasture (ha)	Grassland (ha)	Vine (ha)	Orchards (ha)	Total (ha)
Sibiu	Land in the public domain	113.12	17.85	48.79	63.96	182.2	426
	Private land	3,064.43	3,803.38	2,448.58	857.43	1,595.15	11,768.97
	Total	3,177.55	3,821.23	2,497.37	921.39	1,777.35	12,194.89

Source: own processing.

The data analysis shows, for example, that out of a total of 116.18 hectares of arable land, 113.12 hectares are contracted, and in the case of pastures, hayfields, vineyards and orchards, the entire state-owned public area was contracted. The deepening of the studies regarding the contracting of the lands in public and private property of the state and administered by the State Domains Agency from Sibiu County highlights the existence at the level of 2020 of a number of 85 concession/lease/lease contracts underway in Sibiu County. Their distribution by types of contracts shows the following structure: 20 concession contracts (Fig.1), 41 concession contracts by direct award, 23 lease contracts and 1 rental contract.

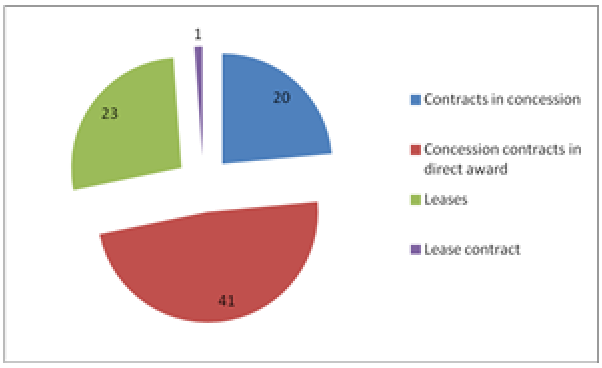

Fig. 1. Number of ongoing contracts in Sibiu County
Source: Own design.

Leasing of agricultural land belonging to the public and private domain of the state located in Sibiu County has the following features: orientation towards the categories of living use, orchards, hayfields when it comes to leasing land belonging to the public domain of the state; orientation towards the categories of living use, respectively arable when it comes to the lease of lands belonging to the private domain of the state; Thus, in 2020 the leased area totals 383.11 hectares of arable land, 201.46 hectares of pastures, 298.34 hectares of hayfields, 482.24 hectares of vineyards and 192.24 hectares of orchards, in total (Table 5).

The concession of agricultural lands belonging to the public and private domain of the state located in Sibiu county presents the following particularities: the orientation towards the categories of arable use, respectively hayfields when it comes to the concession of lands belonging to the public domain of the state; orientation towards the categories of use pastures, arable land, hayfields when it comes to the concession of lands belonging to the private domain of the state; Thus, in 2020 the concessioned area totals 707.76 hectares of arable land, 1,297.77 hectares of pastures, 495.33 hectares of hayfields, 248.44 hectares of vineyards and 745.71 hectares of orchards, in total (Table 6).

Table 5. Situation of leased agricultural land under the administration of A.D.S.

County	Domain type	Arable land (ha)	Pasture (ha)	Grassland (ha)	Vine (ha)	Orchards (ha)	Total (ha)
Sibiu	Land in the public domain	3.67	7.32	24.09	63.96	37.78	136.82
	Private land	379.44	194.14	274.25	418.28	154.46	1,420.57
	Total	383.11	201.46	298.34	482.24	192.24	1,557.39

Source: own processing.

Table 6. The situation of the concessioned agricultural land areas under the administration of A.D.S.

County	Domain type	Arable land (ha)	Pasture (ha)	Grassland (ha)	Vine (ha)	Orchards (ha)	Total (ha)
Sibiu	Land in the public domain	109.04	5.12	16.99	0	0	131.15
	Private land	598.72	1,292.65	478.34	248.44	745.71	3,363
	Total	707.76	1,297.77	495.33	248.44	745.71	3,495

Source: own processing.

Concession by direct allocation of agricultural land belonging to the public and private domain of the state located in Sibiu County has the following features: orientation to the category of orchards when it comes to the concession by direct allocation of land belonging to the public domain of the state; orientation towards the categories of arable use, pastures, hayfields, orchards when it comes to the concession by direct allocation of lands belonging to the private domain of the state; Thus, in 2020, the area concessioned by direct allocation totals 2,086.68 hectares of arable land, 2,322 hectares of pastures, 1,703.70 hectares of hayfields, 190,71 hectares of vineyards and 839,40 hectares of orchards, in total (Table 7).

Table 7. Situation of agricultural land granted by direct allocation under the administration of A.D.S.

County	Domain type	Arable land (ha)	Pasture (ha)	Grass-land (ha)	Vine (ha)	Orchards (ha)	Total (ha)
Sibiu	Land in the public domain	0.41	5.41	7.71	0	144.42	157.95
	Private land	2,086.27	2,316.59	1,695.99	190.71	694.98	6,984.98
	Total	2,086.68	2,322.00	1,703.70	190.71	839.40	7,142.49

Source: own processing.

The centralization of the data regarding the lease and concession of agricultural lands belonging to the public and private domain of the state under the administration of the State Domains Agency and located in Sibiu county presents the following distribution of areas by

contract categories: lease (1,557 hectares); concession (3,495 ha), respectively concession by direct allocation (7,142 hectares). We mention that regarding the category of use pastures and hayfields (meadows) a total area of 499.8 hectares of land was leased by lease; 1,793.1 hectares of land by concession, respectively 4,025.7 hectares of concession by direct allocation.
The concession of the agricultural lands mentioned above, represents through the royalty fixed by the contract, a permanent source of income and guaranteed at the level of the state budget. It is very important to note that the person who deals with the conservation, maintenance and operation of agricultural land that has been received in concession, has a legal obligation to bear all the costs of these operations. Through the concession, the state seeks to ensure that the investments required for the management of the allocated agricultural land are also borne by the concessionaire. The latter also has the duty to pay the taxes and duties related to the lands received in the concession.
In order to achieve the most efficient exploitation of the concessioner land, the tender procedure is used, as it creates the conditions for a transparent environment between all potential concessionaires who have the same object of activity, for the award of the concession contract. Leasing and concession are defining elements in the characterization of the functioning of the State Domains Agency for the realization of which a set of work processes is developed (execution processes and managerial processes). The managerial process developed is a specific one and is achieved by going through certain stages that follow one another and for the accomplishment of which certain operations are performed. They are based on the fact that each type of contract is concluded and performed in legal conditions, by complying with all contractual clauses and implicitly the legal provisions provided in the Laws governing the performance in conditions of efficiency and effectiveness. Based on the statements, the methodological framework for monitoring lease and concession contracts is organized, which highlights the necessary actions both by the State Domains Agency and by the contractual partners. This involves the use of several documents, among which we must mention: the lease or concession contract with the adjacent annexes; account statements certifying the receipt of payments; the report of possession; technical-operative file of the contractual partner; minutes of scoring; information and decision notes; invoices and payment notices; crop structure, etc. (Norms regarding the activity of following the contracts). The documents referred to have an essential role to play in obtaining receipts for leases or concessions. After receiving the contracts, the operation of verifying all the contractual clauses is performed and the client's file is opened and the mentioned data are entered in the computerized data management system.

CONCLUSIONS

The research entitled Management of the activity of leasing and concession of agricultural land belonging to the public and private domain of the state located in Sibiu County highlights a number of features given by the lack of transparency, efficiency and effectiveness of specific actions.
The research is a descriptive and explanatory study on the management of concession and lease of agricultural land found in the state, based on the most important opinions expressed by the literature and statistical data provided by the National Institute of Statistics in Romania.
The administration, respectively the proper management of the agricultural lands that are found in the private or public property of the state by the beneficiaries of the lease and concession contracts represents a current and complex topic of major interest for the responsible factors.
The categories of use of agricultural land in the public and private domain highlight the relevance and the large share of the categories of use of pastures and hayfields at the level of the studied territorial territorial unit, as shown in Tables 1 and 2.

At the level of Sibiu county, the research carried out highlights the existence of an area of 13,863.75 ha in the private domain of the state and in the administration of the State Domains Agency, of which pastures and hayfields hold more than 50%, according to Table 3.

The contracting of the lands in the public and private property of the state and administered by the State Domains Agency from Sibiu County highlights the existence at the level of 2020 of a number of 85 concession/lease/ rental contracts underway in Sibiu County.

The land areas under the administration of the A.D.S. leased in 2020 shows the orientation of farmers towards the categories of use of vines and arable land (Table 5).

The land areas under the administration of the A.D.S. granted in 2020 shows the orientation of farmers towards the categories of pasture, orchard and arable land use (Table 6).

The land areas under the administration of the A.D.S. granted by direct allocation in 2020 highlights the orientation of farmers towards the categories of use pasture, arable land, hayfields (table 7).

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RATIONALE OF CLIMATE RISK MANAGEMENT MECHANISMS IN THE REGIONS OF THE RUSSIAN FEDERATION WITH CROP SPECIALIZATION

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Abstract

The growing number of dangerous weather events, an increase in their duration and amplitude of action leads to sharp fluctuations in agricultural production, thereby creating risks for sustainable development and ensuring food security of the country. The aim of the study is to analyze the peculiarities of the manifestation of hazardous weather phenomena in the regions of the Russian Federation with crop specialization and to substantiate the actual mechanisms of adaptation of regional agrosystems to the consequences of the transformation of natural and climatic conditions. The use of the author's methodology for assessing the level of influence of climatic risks on agricultural production made it possible to establish that the increase in the number of unfavorable meteorological phenomena and the degree of their impact occurs more intensively in the most productive regions of crop specialization. The differentiated impact of climate risks necessitates the creation of regional and sectoral models of adaptation of regional agrosystems, taking into account the peculiarities of natural-resource potential, changes in crop productivity in response to changes in climatic variables, the structure of crop producers in the region. Mechanisms and tools for adapting agricultural systems to the consequences of climate change for the regions involved in the study are formulated.

Key words**:** *agri-food complex, climate change, crop production, climate risk, adaptation, strategy, mechanism*

INTRODUCTION

From the point of view of the world community, the risks driven by climate change, in terms of the probability of occurrence and the expected size of losses, are among the most significant risks threatening the world. Already in the short and medium term, a change in the conjuncture of the global agri-food market is expected due to shifts in the structure of world agricultural production under the influence of a shift in temperature regimes and changes in productivity.

A large number of studies have been devoted to analyzing the impact of climate change on agricultural production in recent years. Assessment reports of the Intergovernmental Panel on Climate Change (IPCC), the Food and Agriculture Organization of the United Nations (FAO) are published regularly. In the annual report of the World Economic Forum on global risks "Global Risks Report 2021" as one of the most important in the medium and long term, the problem of climate change is identified, leading to a spatial shift in agricultural production and the redistribution of resources [22]. A complex combination of social, climatic and environmental risks threatens to deviate from the vector of sustainable development of socio-economic systems, transform established economic ties and chains, reduce the level of physical availability of food, and destabilize the process of ensuring food security of countries. The results of a retrospective analysis indicate that the repetition of several lean years leads to fluctuations in yields and agricultural production volumes, disruption of food chains and a sharp reduction in carry-over stocks of agricultural products, destabilizing the provision of domestic food consumption [13].

Researchers from different countries note that the number of climatic anomalies and natural disasters at the macro level in recent decades has increased by 4 times - in terms of climatic disasters, and 6 times - in hydrological ones

[4]. At the same time, in the countries with the most productive agriculture, an increase in the number of negative weather events, their duration and intensity was observed.

The main conclusions made by Russian researchers can be boiled down to the fact that the impact of climate change on the prospects for the development of agriculture in Russia can be regarded as moderately negative [12, 20]. It is believed that the potential climatically conditioned increase in gross harvests of grain and other basic crops in the regions of the Central Non-Black Earth Region, the North-West and the Far East will positively affect the state of food security in macroregions. Taking into account natural and climatic risks in regional strategies of socio-economic development exists only in the form of a statement of the presence of such factors (risks) [19, 6]. At the same time, the unpredictability of the onset of unfavorable weather events, an increase in their number and intensity, will neutralize the softening of temperature regimes and the expected increase in productivity in crop production in more northern regions.

The current regulatory framework does not facilitate their mandatory analysis and quantitative accounting when developing or adjusting strategies, which is a violation of the principle of realistic strategic planning. The significance of the factor of hazardous weather phenomena in the system of strategic priorities is certainly underestimated. At the same time, the growing number of dangerous weather events, an increase in their frequency and amplitude of action, can create risks for the sustainable development of agriculture and food security of the country.

An integrated approach to climate risk management includes three sequential stages: collection and processing of information on climate threats and risk recipients; identification and assessment of risks, forecasting their changes; implementation of measures to adapt to climate risks, as well as monitoring the results of their implementation. Without complete information about the intensity and geography of hazardous phenomena, as well as the exposure of the economy and society to them, it is impossible to assess the scale and dynamics of climate risks. Without a quantitative assessment of risks, it is difficult to build a system of adaptation measures aimed at mitigating the consequences of their impact.

The aim of the study is to identify trends in the influence of hazardous weather events on the main indicators of crop production in the most productive regions of the Russian Federation and to substantiate the actual mechanisms of adaptation of regional agricultural systems to the consequences of global climate change. Achieving this goal involves solving the following tasks: studying the regional features of the manifestation of natural and climatic risks, assessing their impact on the productivity of basic agricultural sectors, justifying adaptation measures to mitigate the consequences of the negative impact of climatic factors. Regional differences create an objective basis for the development of sectoral and regional strategies for adaptation to the consequences of global climate change. The calculations performed and the conclusions made on their basis will allow substantiating the most relevant mechanisms for the sustainable development of the plant growing sub-industry to global climate changes, as well as contribute to the development of a differentiated strategy for the development of regional agrosystems.

MATERIALS AND METHODS

The research methodology is based on a set of conceptual provisions for sustainable development and climate-smart agriculture, developed by the Food and Agriculture Organization of the United Nations (UN FAO) [9]. The approaches to sustainable development described in the 2011 Human Development Report provide a clear justification for the presence of a synergistic component in the influence of factors that weaken or enhance the resilience of socio-economic systems [7, 8]. They are viewed in terms of nonlinear linkages and trade-offs between sustainability, ecology and equality of opportunity.

Today, the principle of dynamically balanced development of the economy-nature-society triad, when implemented, faces a number of problems and limitations. Existing approaches imply inconsistent, often isolated solutions to problems. Analysis by the United Nations Environment (UNEP DTU) indicates that most countries (72%) have adopted at least one national adaptation planning tool, and a number of countries (9%) are currently do not have such a tool, are in the process of developing it. According to the 2020 Adaptation Implementation Gap Report, huge gaps remain in implementation in developing countries and in bringing adaptation projects to the point where they provide real protection against climate impacts such as droughts, floods and sea-level rise [24]. The question of what policies, innovations and institutions are needed to eliminate or mitigate the negative side effects of climate change has become fundamental [23].

To develop strategies and measures for the adaptation of socio-economic systems, it is necessary to study the problem from different angles, determine the significance of the influence of various factors, study the institutional environment, the available resource potential, etc. The problems of the impact of climate change on agricultural production are reflected in a whole array of research works by Russian and foreign scientists. Andryushchenko S.A. [1, 2] in a number of his works systematizes climatic factors that have a direct and indirect impact on the competitiveness of the agri-food complex. The study of climate influence on structural changes in agricultural production and the associated change in the level of food security of the Russian Federation was carried out by M. Yu.Ksenofontov, D.A. Polzikov [12]. The authors provide an economic justification for the fact that in the long term, global climate change will not have such a negative impact on the development of agriculture in Russia.

The role of the climatic factor in the development of the Russian agri-food complex in the system of strategic priorities is reflected only in the form of an increase in the average temperature by 1.5°-2.2° and a uniform shift in the temperature gradient. At the same time, the differentiated impact of climatic risks is underestimated, which increasingly began to manifest themselves in the most fertile regions of the Russian Federation. Examples of scientific works devoted to a detailed consideration of the frequency of occurrence of various types of hazardous meteorological phenomena and their impact on the regional economy are the studies of A.N. Petina and M.V. Brykalova [16], P.V. Druzhinin [5], V.M. Katsov and others [3, 10]. Comprehensive study of the influence of unfavorable weather (agrometeorological) phenomena on the processes of growth, development and formation of productivity of cultivated crops, on the massive development of pests and diseases that cause serious damage to the formation of crop yields was carried out by Gringof I.G. and Kleshchenko A.D. [6]. Rusin I.N. summarized the approaches underlying the construction of modern methods of forecasting the impact of natural disasters [18].

The issue of assessing the impact of climate change on agricultural development is complex and interdisciplinary. To study it qualitatively, it is necessary to synthesize a systemic, institutional, logical and comparative scientific approach. Their consolidation, accompanied by spatio-temporal analysis, will make it possible to comprehensively approach the development of a strategy for adapting regional agrosystems.

The methodological approach proposed by the authors includes several stages of research. The study is based on the classification of the constituent entities of the Russian Federation by the specific weight of the region's crop production in the total volume of the country's crop production. The grouping of regions was carried out using the method of cluster analysis based on data from selective federal statistical observation on agricultural production. In each of the obtained classification groups of regions, an analysis of the dynamics of hazardous weather phenomena in the context of their types was carried out, as well as visualization of the results of the analysis of the temporal variability of indicators of climatic risks. Using the methods of correlation and regression analysis, the relationship between production and climatic variables is determined.

The final stage of the study includes the substantiation of priority mechanisms for adapting regional agrosystems to climate change, taking into account the current state of the industry and its production potential.

To solve the set tasks, an information base of the study was collected, which includes the values of indicators calculated using: materials of the Federal Statistical Observation on the development of the plant growing sub-industry in the regions of the Russian Federation, bulletins and annual reporting materials of the Ministry of Agriculture of the Russian Federation, summary information of the National Union of Agricultural Insurers on sales agricultural insurance programs in the regions, data from the Federal Agency for Support of State Support Programs for the Agro-Industrial Complex on the allocation of budgetary assignments for the development of subsidized agricultural insurance. The information array of weather characteristics in the context of the constituent entities of the Russian Federation was formed on the basis of data provided by the Federal Service for Hydrometeorology and Environmental Monitoring (Roshydromet). Using the methods of economic and statistical analysis, a set of statistical data was processed, the main climatic and production indicators were correlated. An idea of the differentiated impact of climatic risks in the regions of the Russian Federation with different levels of crop specialization was obtained.

RESULTS AND DISCUSSIONS

For the distribution of the regions of the Russian Federation into groups, the share of the region's crop production in the total volume of the country was taken as a classification indicator. The analysis included regions, in each of which it was in the period from 2009 to 2019 exceeded 1%.

The principle of constructing the classification is based on comparing data for the region with the average values of the corresponding indicator for the Russian Federation.

The selected groups of constituent entities of the Russian Federation are considered in the space of climatic factors (number, main types: abnormally cold and hot weather, wind, rainstorm, flood, sudden weather changes, extreme fire hazard, etc.) and the average gross harvest of grain and leguminous crops for last 10 years.

The first group includes the leading regions in terms of the share of crop production in the total volume of the Russian Federation: Krasnodar and Stavropol Territories, Voronezh and Rostov Regions, as well as the Republic of Tatarstan. Agriculture in these regions is the most productive due to favorable basic natural and climatic conditions, a developed level of infrastructure, and the presence of large export-oriented agro-food organizations. Despite the fact that the regions included in the first group have a smaller sown area, in contrast to most regions of the second group, they account for the bulk of the produced crop production (grain and leguminous crops, sunflower).

The specific weight of crop production produced in the Krasnodar Territory accounts for 10% of the total volume of crop production in the Russian Federation.

At the same time, the size of the sown area of the Krasnodar Territory is 3,727.22 thousand hectares. Similar indicators: Stavropol Territory 5% with a sown area of 2,937.41 thousand hectares, Rostov region 6.8% with a sown area of 4,747.95 thousand hectares, Voronezh region 3.9% with a sown area of 2,685.94 thousand hectares, and The Republic of Tatarstan 4.2% with a sown area of 2,870.62 thousand hectares (Table 1).

The plant growing sub-industry is of strategic importance for the implementation of the existing resource and natural-climatic potential of the listed regions.

On average, for this group, crop production accounts 70% of the total agricultural production. This sub-sector employs on average more than 63% of agricultural organizations and 84% of peasant (farmer)

households.
Analyzing the first group of regions in terms of climatic factors, it should be noted that the average number of dangerous weather events significantly exceeds the average value of this indicator in the Russian Federation.

Table 1. Grouping of regions of the Russian Federation according to the average value of the share of crop production of the region in the total volume of crop production of the Russian Federation for 2009–2019

Average share of crop production in the region in its total volume in the Russian Federation,%	The subject of the Russian Federation	Average gross harvest of grain and leguminous crops, thousand tons	Average number of dangerous weather events per year, units	Correlation coefficient
4.4	Voronezh region	3,990.7	6.36	-0.581
	Krasnodar region	12,337.8	57.45	-0.114
	Republic of Tatarstan	3,468.5	13.82	-0.240
	Rostov region	9,446.8	11.18	0.048
	Stavropol region	8,220.9	35.00	-0.589
1.9	Altai region	4,224.6	41.91	-0.114
	Belgorod region	2,950.1	4.91	-0.710
	Volgograd region	3,491.4	6.18	-0.236
	Kursk region	3,736.8	8.82	-0.692
	Lipetsk region	2,483.4	4.36	-0.291
	Orenburg region	2,338.9	7.27	-0.355
	Republic of Bashkortostan	2,633.3	9.45	-0.058
	The Republic of Dagestan	310.3	11.55	-0.513
	Samara Region	1,643.5	9.82	-0.878
	Saratov region	3,099.0	6.09	-0.574
	Tambov Region	2,845.5	4.27	-0.727
1.1	Amur Region	327.6	6.09	0.431
	Moscow region	305.9	5.09	0.018
	Novosibirsk region	2,246.6	24.09	-0.532
	Omsk region	3,016.5	6.64	-0.685
	Orel Region	2,680.5	4.00	-0.622
	Penza region	1,406.5	3.82	-0.408
	Tula region	1,419.2	1.91	-0.103
	Chelyabinsk region	1,535.1	12.18	-0.620

Source: own calculations.

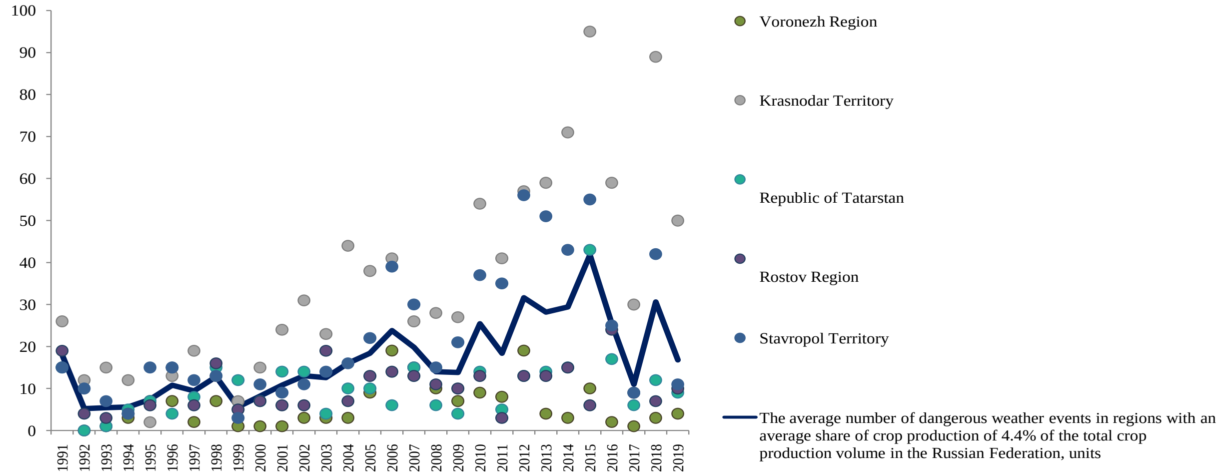

Fig. 1. The dynamics of unfavorable hydrometeorological phenomena recorded in the regions of the first classification group for 1991-2019.
Source: own calculations based on data from the Federal Service for Hydrometeorology and Environmental Monitoring (Roshydromet) [17].

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Moreover, since 1999, on their territory, there has been a tendency to an increase in the number of climatic risks with an increasing amplitude of action (Figure 1): the equation of the trend line $y = 10^7\text{-}05x^2+0.782x+5.117$, with the determination coefficient $R^2 = 0.511$.

In the structure of climatic risks, the most typical for this group of regions are intense heat, wind, extreme fire hazard, hail, downpour, floods. During the period under consideration, weather anomalies had the greatest negative impact on the Stavropol Territory and the Voronezh Region. The correlation coefficient between the indicators of the gross harvest of grain and leguminous crops and climatic variables (the number of the most frequent unfavorable meteorological events) was -0.581 and -0.589, respectively. Despite the fact that the regions of the first classification group are experiencing the growing impact of dangerous weather events, the balanced financial result of agricultural organizations from year to year remains positive and is achieved due to the size of the cultivated areas, as well as the implementation of state support measures. However, the potential for sustainable development of crop production in these regions may decrease not only due to an increase in the number of climatic risks, but also an increase in their duration and amplitude of action. The most prolonged phenomena were such as extreme heat, wind and extreme fire hazard.

The regions of the second classification group are the undoubted leaders in terms of sown area in Russia: Altai Territory (5,175.85 thousand hectares), Orenburg region (4,285.6 thousand hectares), Saratov region (4,168.7 thousand hectares), Volgograd region (3,090.87 thousand hectares). But the productivity of the plant growing subsector is lower there, although it is close to the average for the Russian Federation - 2.1%.

The regions of this group are characterized by the temperate climate of the Central part of Russia and similar weather characteristics (Figure 2).

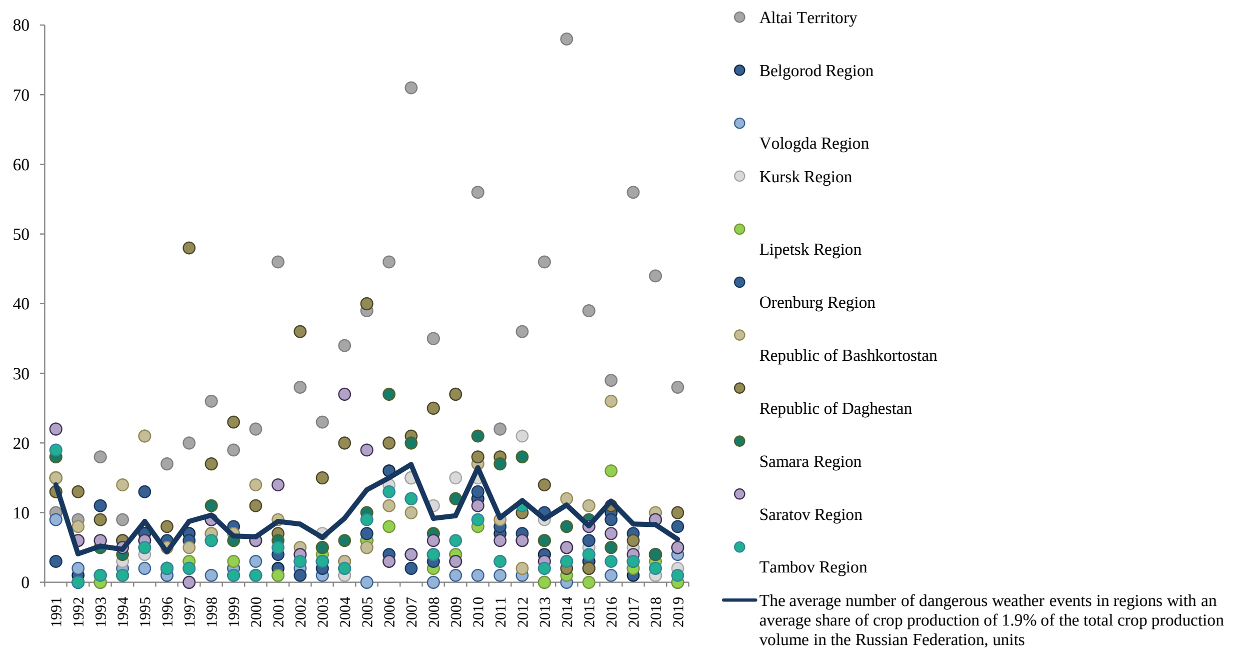

Fig. 2. The dynamics of unfavorable hydrometeorological phenomena recorded in the regions of the second classification group for 1991-2019.

Source: own calculations based on data from the Roshydromet [17].

Analysis of the dynamics of the gross harvest of grain and leguminous crops and the number of hazardous weather events in the regions of the second classification group showed their inverse relationship. A regularity is noted here - a greater number of hazardous weather events in the territories of regions with the highest indicators of crop production and the available natural resource potential.

The type of climatic risk is of great importance. In the structure of unfavorable meteorological phenomena in the territories of the regions of the second classification group, wind, drought, intense heat and extreme fire hazard prevail. 2009 to 2019 The greatest destabilizing effect of weather anomalies was in Belgorod (-0.710), Kursk (-0.692), Samara (-0.878) and Tambov (-0.727) regions. This was reflected in the dynamics of the financial results of agricultural organizations with a delayed effect of one to two years [14]. Considering that in the regions of this classification group, half of the producers of crop production are small businesses, the share of unprofitable organizations increased in those years when the maximum number of dangerous weather events occurred.

A similar trend is typical for the regions included in the third classification group. The Moscow and Amur regions were exposed to the minimum impact of weather anomalies (on average 5 and 6 times a year). The maximum number of unfavorable weather events in the group occurred in the Novosibirsk region (on average, 24 times a year). The analysis of the time series showed that the regions of the second and third classification groups for the studied period of time on average accounted for the same number of dangerous weather events as the average for the Russian Federation (Figure 3).

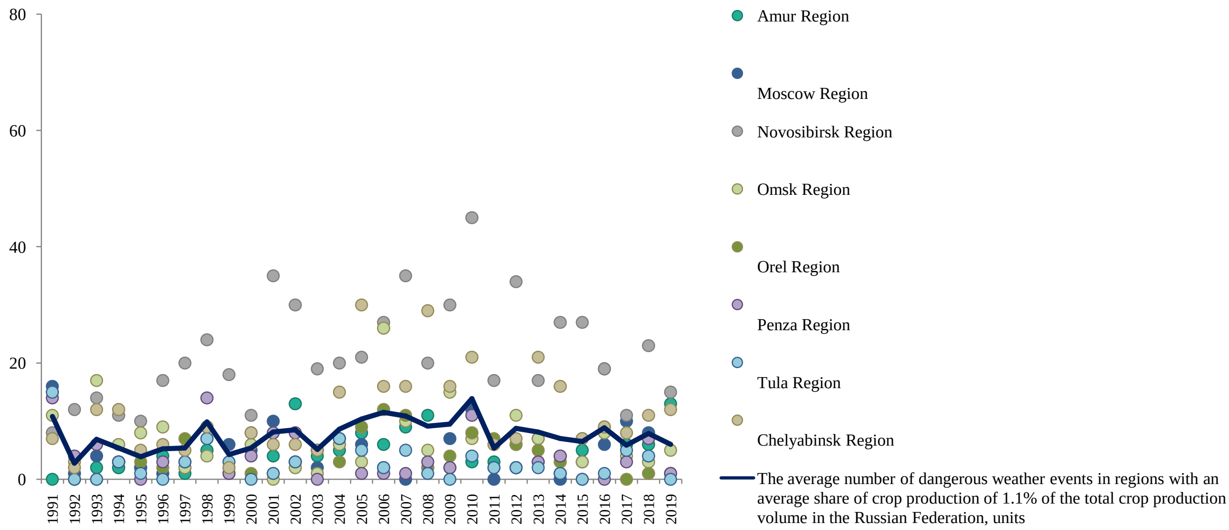

Fig. 3. The dynamics of unfavorable hydrometeorological phenomena recorded in the regions of the third classification group for 1991-2019.
Source: own calculations based on data from the Roshydromet [17].

Analysis of the spatial and temporal data obtained using the information arrays of the Roshydromet on hazardous weather phenomena, the regional satellite remote sensing system allows us to conclude that an increasing number of hazardous weather events in the territory of most constituent entities of the Russian Federation specializing in crop production. Correlation-regression analysis showed a strong inverse relationship between the increase in the number of dangerous weather events and the gross yield of basic crops [15, 11]. In addition, factors that have an indirect effect on the dynamics of the index of crop production are increasingly manifesting themselves: global structural transformations, changes in the world market situation, the development of digital technologies and the degree of their implementation, pricing policy, etc.

Fluctuations in the dynamics of yields in the most productive regions lead to an unstable volume of crop production, which poses a threat to sustainable food consumption by the population and ensuring the country's food security. The growing influence of unfavorable natural and climatic phenomena makes significant adjustments to medium- and long-term development forecasts and the formation of an export-oriented model of the agro-industrial complex.

The strategic goal of state regulation of crop production is its sustainable dynamic development. Adaptation of agri-food systems is one of the areas of their sustainability. The architecture of the adaptation mechanism includes institutional, organizational and economic measures to reduce (mitigate) the consequences of climate risks.

The institutional basis of the state policy of adaptation of Russian agriculture to global climate change is made up of a number of normative legal documents at the national (federal) level and in the sectoral context [24]. (Table 2)

Table 2. Normative documents defining the Russian national agro-food policy in the field of climate change (all in Russian)

№	Denomination	Year/No.
1	Climate doctrine of the Russian Federation	Order of the President of the Russian Federation of December 17, 2009 No. 861-rp
2	Strategy for activities in the field of hydrometeorology and related fields for the period up to 2030 (taking into account aspects of climate change)	Order of the Government of the Russian Federation dated 03.09.2010 No. 1458-r
3	Comprehensive plan for the implementation of the Climate Doctrine for the period up to 2020	Order of the Government of the Russian Federation dated April 25, 2011 No. 730-r
4	State program for the development of agriculture and regulation of markets for agricultural products, raw materials and food for 2013-2020 (extended until 2025)	Government Decree of July 14, 2012 No. 717
5	Decree of the President of the Russian Federation "On the reduction of greenhouse gas emissions"	Decree of September 30, 2013 No. 752
6	Federal Scientific and Technical Program for the Development of Agriculture for 2017 - 2025	Resolution of August 25, 2017 No. 996
7	National action plan for the first stage of adaptation to climate change for the period up to 2022	Order of the Government of the Russian Federation of December 25, 2019 No. 3183-r

Source: compiled by the authors.

At the same time, an analysis of the content of the Federal Scientific and Technical Program for the Development of Agriculture for 2017 - 2025 showed the absence of a climate risk factor as the most important area of research. In addition, the problem of climate risks is still not properly reflected in the system of strategic priorities at the regional level.

Analyzing the dynamics of unfavorable hydrometeorological phenomena in the regions of crop production, it can be concluded that the consequences of climatic changes are differentiated from region to region. Therefore, we believe that the formation of regional climate strategies for the development of agro-food systems should become an effective measure of adaptation to climate change. Undoubtedly, regional climatic and resource characteristics will determine the specific content of adaptation strategies. Taking into account the classification of regions, we propose the most appropriate mechanisms for the selected groups of regions for adapting the crop production sub-industry to the consequences of global climate change (Figure 4).

Agricultural insurance is recognized as one of the main adaptation tools noted by the UN FAO in the framework of climate-smart farming. This is the most important mechanism of the stabilizing system, contributing to the formation of the prerequisites for the financial stability of agricultural producers in the event of risks.

The most widespread in Russian conditions is voluntary agricultural insurance subsidized from the federal budget. However, the coverage of crop production with insurance coverage based on government support remains insufficient. As a result of the institutional reforms carried out in recent years in the sector of subsidized agricultural insurance, the share of the sown area of insured crops decreased from 17.1% in 2014 to 2.3% in 2017 and 1.7% in 2018 [21]. This became one of the reasons for the insufficiently effective use of budget funds allocated for the development of agriculture, which did not allow achieving the required target indicators (balanced financial result, the proportion of unprofitable organizations, gross harvest of major agricultural crops) in crop production in certain regions.

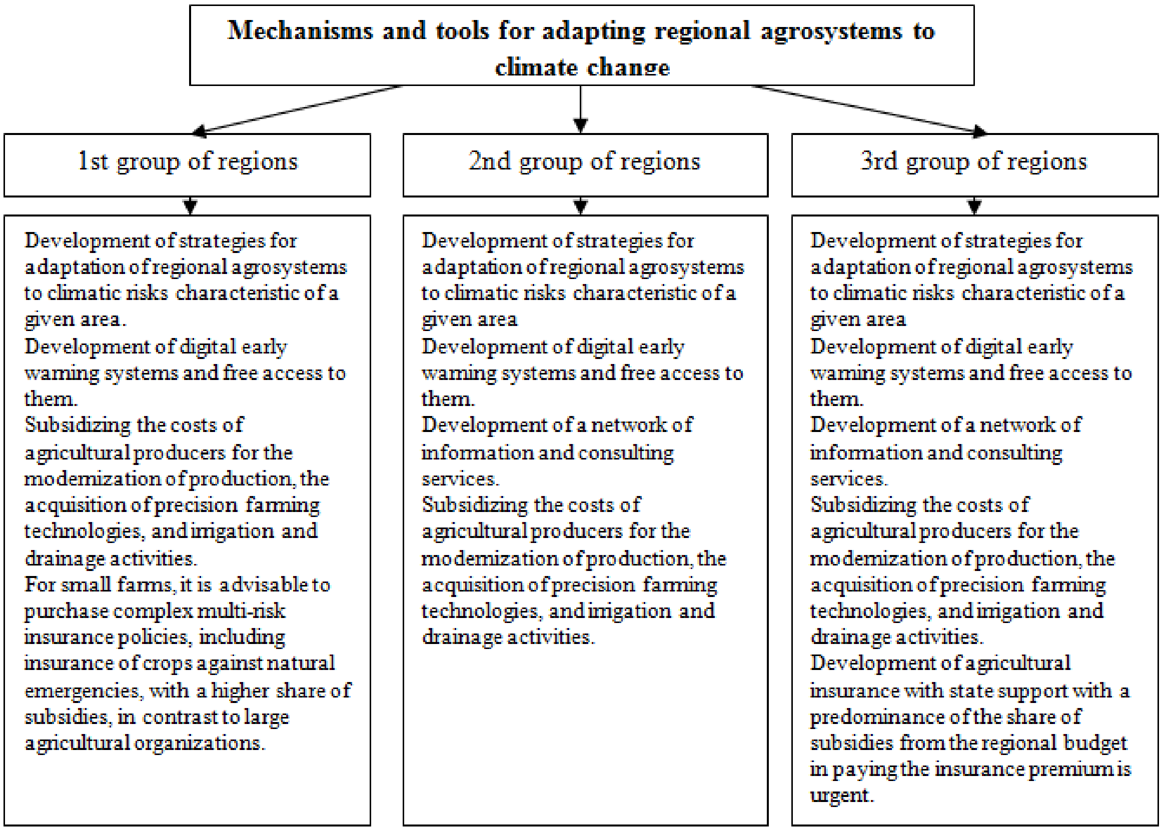

Fig. 4. Mechanisms and tools for adaptation of regional agrosystems 1, 2 and 3 groups to climate change.
Source: own developments

Since 2020, amendments have been made to federal legislation, the list of incentive measures for its development has been increased: the list of insurance risks has been expanded; the threshold level of loss (death) of the crop was canceled; the maximum deductible was increased from 30% to 50%; it became possible to insure certain risks, which is especially important for small farms.

The results obtained make it possible to formulate proposals for the development of agricultural risks insurance for the regions of each of the identified classification groups. For regions with small cultivated areas (Moscow and Amur regions), the development of agricultural insurance with state support with a high share of the regional budget in the allocated subsidies for paying the insurance premium is of the greatest relevance. This measure is also expedient for the constituent entities of the Russian Federation, the territories of which belong to territories that are unfavorable for the production of agricultural products. Among the regions included in the study are the Volgograd Region and the Republic of Dagestan. In the regions with the largest cultivated areas (Krasnodar, Stavropol and Altai Territories, Novosibirsk and Chelyabinsk Regions, the Republic of Tatarstan), an increase in the number of unfavorable natural and climatic phenomena is noted. At the same time, a characteristic feature is the predominance of small business entities in the structure of crop producers. In this regard, it seems most expedient to purchase complex multi-risk insurance policies, including insurance of crops against natural emergencies, with a higher share of subsidies, in contrast to agricultural organizations.

Summarizing the goals and objectives of the normative documents listed in Table 2 that define the Russian national agri-food policy in the field of climate change, analyzing a number of measures laid down for their implementation, it should be noted such shortcomings as inconsistency and fragmentation of coverage. An integrated approach to climate risk management should consistently include three stages: collection and processing of information on climate risks; their identification and assessment, forecasting changes; implementation of measures to adapt to climate threats and risks, monitoring of the results of the implementation of the measures taken.

Without complete information about the intensity and geography of hazardous phenomena, as well as the exposure of the economy and society to them, it is impossible to assess the scale and dynamics of climate risks. Without a quantitative assessment of risks, it is difficult to build a system of adaptation measures aimed at mitigating them. Therefore, when developing state programs, strategies for socio-economic and sectoral development, we consider it necessary to include in the methodological base the requirements for the presentation of quantitative characteristics of risk factors with the fixation of the limit values of these characteristics, exceeding which requires prompt action up to adjusting the state program or strategy. In this aspect, the development of digital early warning systems and free access to them are essential.

The adaptive potential of regional agrosystems also includes the introduction of digitalization means in the production and management of the agri-food complex. The digital infrastructure is represented by a large number of Russian and foreign organizations that develop and implement both separate software and comprehensive services for the entire cycle of agrotechnical activities. The digital solutions tool opens up opportunities for the structural and technological adaptation of agricultural producers themselves to the negative consequences of climate change. The most accessible and popular are precision farming technologies (differentiated irrigation and fertilization, etc.). This necessitates the development of information and consulting services of the agro-industrial complex, both at the regional and municipal levels.

Since 2019, in the pilot regions of the country, the formation and implementation of regional strategies for adaptation to the consequences of climate change has been taking place. These regions are Altai Territory, the Komi Republic, Saratov and Murmansk Regions, St. Petersburg. The implementation of pilot projects will largely contribute to the creation of examples of the formation of adaptation plans - from methods for collecting and processing information on climate risks to planning and implementing specific measures to mitigate them, with the aim of further spreading them to other regions of Russia facing similar problems.

CONCLUSIONS

Methodological approaches to the study of the relationship between climate change and agricultural production are implemented on the example of regions of crop specialization. An analysis of the dependence of the yield of the grain industry on the growing number of hazardous weather events, an increase in their amplitude and frequency, indicates a significant negative impact of climatic anomalies on the sustainable development of agriculture.

According to the results of the study, a more intensive increase in the number of unfavorable meteorological phenomena and the degree of their influence in the most productive regions - included in the first classification group - was established. For the second and third classification groups, a similar pattern remains: a greater number of hazardous weather events in regions with increased rates of crop production and natural resource potential.

Regional differences create an objective basis for the development of sectoral and regional strategies for the development of agricultural systems. Therefore, along with the classical form of strategic planning, a differentiated approach should be used, taking into account the regional characteristics of the natural resource potential, the change in the productivity of agricultural crops in response to changes in climatic variables, the structure of crop producers in the region.

The author's approach made it possible to formulate mechanisms of adaptation to the consequences of global climate change for each selected group of regions with crop production. Based on the results of the study, it is recommended: development of strategies for adapting regional agrosystems to climatic risks characteristic of a given area; development of digital early warning systems and free access to them; development of a network of regional and municipal information and consulting services; subsidizing the costs of agricultural producers for the modernization of production, the acquisition of precision farming technologies, carrying out irrigation and drainage activities; development of an up-to-date range of agricultural risks insurance tariffs for a given area. For regions of the first classification group with a large share of small farms in the structure of crop producers, it is advisable to use complex multi-risk insurance policies, including insurance of crops against natural emergencies. Moreover, for small agricultural producers there should be a higher share of subsidies for complex insurance policies, in contrast to large agricultural organizations. For the regions included in the third group, the development of agricultural insurance with state support with a predominance of the share of subsidies from the regional budget in paying the insurance premium is relevant.

The obtained practical results and the conclusions drawn on their basis expand the possibilities for setting the tasks of optimal planning and management of the plant growing sub-sector of the most productive regions of the Russian Federation in the context of the probable onset of natural and climatic risks.

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WHO BENEFITS MORE FROM DIRECT MARKETING SCHEMES? THE CASE OF ARABICA COFFEE COOPERATIVE AND ITS FARMERS MEMBER IN RURAL INDONESIA

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Abstract

Cooperatives play a prominent role in the agricultural sector, both in developed and developing countries. This study aimed to examine the cost and profitability of direct marketing between a cooperative and its farmers member. Data were collected based on a direct face-to-face economic survey using the purposive sampling method for a case study of Alam Kerinci cooperative, the biggest arabica coffee cooperative in Kerinci Regency, Indonesia, and its farmers. Cost-profitability calculation analysis was conducted, and the non-parametric Mann-Whitney test was used to examine the differences between the inputs, variables, cost, and profitability. The results highlighted that the cooperative's variable cost was enormous, reaching 98.15% of its total costs, and its major component was purchasing red cherry beans, with a value of 57.80%. For farmers, the largest cost was variable cost (79.51%), with hired labor as the major component, reaching 31.47%. The profitability for the cooperative and its farmers can be demonstrated by the monthly net profit, which was IDR 96,787,500 and IDR 1,714,108, respectively. This confirmed that the cooperative's profit was larger than that of farmers. However, the farmers' cost-benefit ratio was higher than the cooperative's, at 0.87. The implication of this study is that farmers benefitted economically from this scheme. The study makes a novel contribution as it shows that a direct marketing scheme with the cooperative is beneficial to farmers.

Key words*: *profitability, cooperative, coffee, farmer, rural, Indonesia

INTRODUCTION

Coffee is one of the five most important world commodities [13, 29, 9, 20]. In fact, coffee is the second most traded commodity after oil on the world's exchange markets [8]. In addition to being an income source, coffee also produces employment and foreign exchange income. It plays a particularly crucial role in the Indonesian national economy as an export item and has long been cultivated there. Globally, two main varieties of coffee are planted: arabica and robusta. Since 2016, worldwide arabica production (102 million bags; one bag equals 60 kg) has been significantly higher than that of robusta (56 million bags). The largest arabica coffee producing country is Brazil, with 55 million bags produced in 2016, followed by other countries such as Colombia (14.5 million bags) and Indonesia (11.2 million bags). Indonesian arabica coffee production is still relatively low, at approximately 8% of world production, amounting to 637,000 tons in 2017 [26]. One of Indonesia's coffee productions centers is Jambi Province [7]. Potential coffee production centers in Jambi Province include Kerinci Regency, Sungai Penuh City, Merangin Regency, and West Tanjung Jabung Regency. The coffee plants grown in these regions include robusta, arabica, and liberica. One of Jambi Province's largest arabica coffee production centers is Kerinci Regency; the latest data show that coffee plantations there occupied 7,573 hectares or 30% of the land area [27]. Recently, large retailers have entered the coffee market. However, farmers, who are the primary producers and struggle with agricultural production, are not enjoying the benefits of this trend; there has been no great improvement in their financial position and profit [9]. The lengthy Indonesian coffee value chain involves several institutions before the product reaches the end consumer. Farmers commonly sell their coffee to traders or middlemen, and this arrangement is economically detrimental to them [23]. A simplified value chain can benefit producers (farmers) by cutting the cost of middlemen and guaranteeing fair prices [33]. The marketing flow in the study area is illustrated in Figure 1.

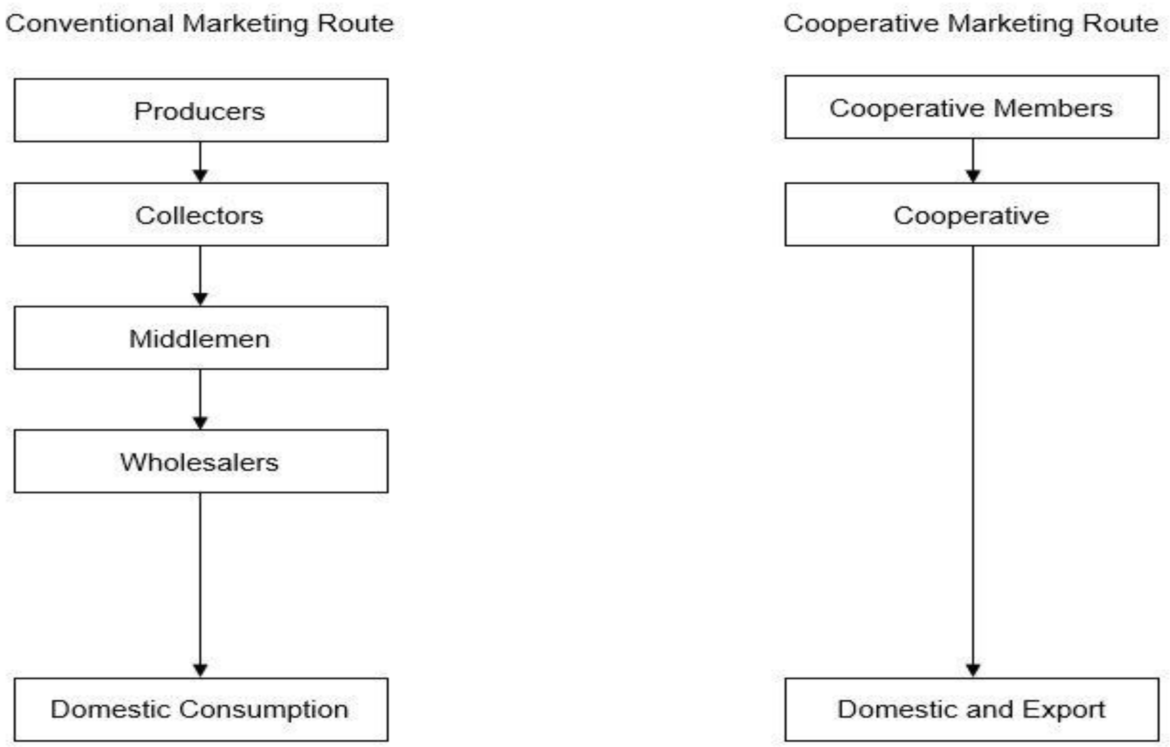

Fig. 1. Arabica coffee marketing flow in the study area
Source: Field survey by the authors.

The literature on arabica coffee farming has focused on climatic suitability and impact certification [25, 15, 2, 32]. A limited number of studies have analyzed arabica coffee marketing [1] and profitability [10]. Furthermore, there is a lack of research on direct marketing costs and profitability involving cooperatives and their farmer members in Indonesia. Panggabean et al. (2019) [19], Rico et al. (2020) [22], and Udayana (2017) [30] studied the strategies and efficiency of Indonesian arabica coffee marketing. They examined past problems, focusing on competitiveness of arabica coffee commodities as agricultural products. The present study differs from the above works as it focuses on the direct marketing system between the basic institution of agricultural cooperatives and their farmer members. Understanding arabica coffee's contribution to the economic sustainability of cooperatives and their membership is essential to future economic sustainability. This is the first study to address this issue using the proposed methodology. To fill the current knowledge gap, this study analyzed the inputs, costs, profitability, and benefits of a direct marketing system between an arabica coffee cooperative and its farmers in rural Indonesia. We focused on a direct marketing scheme using economic survey data to show that with this scheme, no party is impaired—neither the cooperative nor the farmer, who has been the most deprived coffee marketing system participant in Indonesia. This study provides compelling evidence that intermediaries (middlemen), who are detrimental to farmers, are not required. The remainder of this paper is organized as follows. The next section describes the study area. Then we summarize

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the materials and methods and explain the data analysis approach. The following section presents the results and a discussion detailing the socio-demographic, farming, and business characteristics of sample respondents and their statements on arabica coffee. Additionally, the direct selling scheme's cost and profitability is presented. The final section offers the conclusions and recommendations.

MATERIALS AND METHODS

Study Area

Historically, farmer cooperatives in Indonesia have been inseparable from the government's national development program. Their development has always been part of the country's food sufficiency program. Cooperatives establish rural stores that provide members with farm inputs and consumer goods at discounted prices, with guaranteed prices set by the government [28]. The aim of establishing a cooperative was to protect citizens from loan sharks. Earlier, two types of cooperatives were established: saving and loan cooperatives. This list then expanded to include agricultural cooperatives [3]. The growth of rural agricultural cooperatives has been supported by government-backed businesses which, in part, were designed to provide cooperatives with a secure financial base upon which they could develop unsupported businesses to address members' needs [17]. This research was conducted in Kerinci Regency (Figure 2), Jambi Province, Indonesia as a case study of the Alam Kerinci Agricultural Cooperative and its farmer members. This research location and subject were chosen because Kerinci Regency is the biggest arabica coffee production center in Jambi Province, one of Indonesia's most important coffee production centers, and the cooperative is one of the biggest for arabica coffee in Kerinci Regency. Most members are small farmers, and their livelihood is tied to small-scale coffee cultivation. They cultivate on volcanic soils. Volcanic soils originate from previous volcanic eruptions, which introduce three types of materials into the environment: solids, liquids, and gas. Solid materials include sand, dust, and volcanic ash, while liquid materials include lava. These materials decompose into primary soil ingredients. Soil developed from volcanic ash is considered fertile and suitable for agriculture [24].

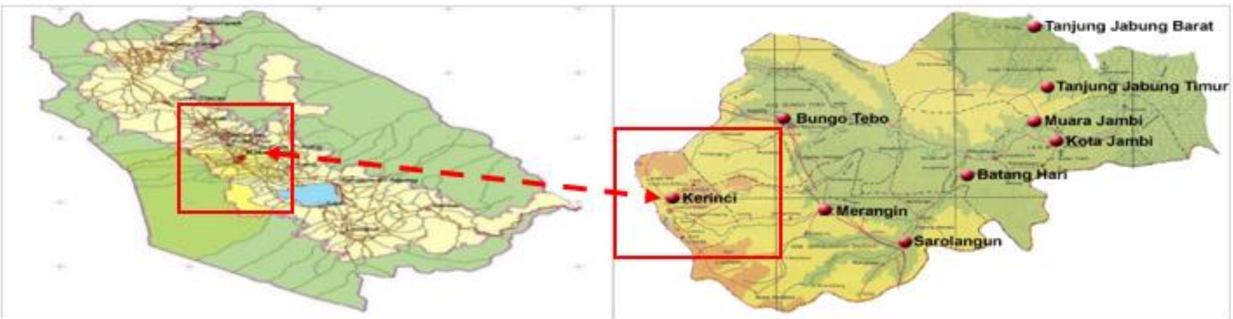

Fig. 2. Map of the study area, Kerinci Regency in Jambi Province.
Source: [21]

In September 2020, in depth-interviews using semi-structured questionnaires were conducted face to face with the cooperative's chief executive officer and its farmer members. The survey extracted data on socio-demographic and economic characteristics from 51 cooperative farmers and cooperative business characteristics using the purposive sampling method. We selected only farmers employed by the cooperative and assumed that they have identical farming characteristics and only grow arabica coffee. Most sell directly to the cooperative, not through middlemen. We confirmed the representativeness of the sample by verifying with the village office and several key informants that Alam Kerinci was the largest arabica coffee cooperative in Kerinci

Regency. We also confirmed with the chiefs of the cooperative that the sampled farmers matched the criteria for our questionnaire. All cost data for both the cooperative and its farmer members were compiled from official cooperative reports at the time of the interview.

Data Analysis

The indicators for all costs were calculated based on the categories of variable costs, fixed costs, and total costs. Variable costs included costs for tools, production costs, materials, electricity, water, gunny sacks, plastic sacks, tarps, fertilizers, herbicides, pesticides, hired labor, marketing, shipping, and transportation. Fixed costs included repairs and maintenance, business permits, land rent, and depreciation; depreciation was calculated using the straight line, which is the simplest and most used method for estimating depreciation. In this method, the annual depreciation is constant; in addition, for determining the depreciation, it is assumed that the value loss is directly proportional to the asset's age [6]. The equation of the straight-line method is expressed as:

$$D_k = (P - S)/n \qquad (1)$$

where:
D_k is the annual depreciation in the k^{th} year (k = 1, 2, n);
P is the purchase price of the asset;
S is the final salvage value in the n^{th} year;
n is the asset's useful life expressed in years.

The data were summarized using descriptive statistics of the mean, percentage, and standard deviation. The calculated profitability indicator was gross profit generated from the sales quantity multiplied by the sales price (cooperative) and yield multiplied by the farmers' sales price. We calculated the net profit generated, namely, the gross profit minus the total cost. Since the number of observations is not large, the parametric test is not appropriate for comparing the groups (in terms of input costs and profitability). In such a case, a non-parametric test (e.g., the median, Mann-Whitney, and Kolmogorov-Smirnov tests) is commonly used in the literature [5, 11, 12]. Using this test gives consistent results [4]; therefore, to test the differences between the inputs, variables, fixed cost, total cost, and profitability, the non-parametric Mann-Whitney test was used. Mathematically, the Mann-Whitney U statistics are defined as follows for each group [18]:

$$U_x = n_x n_y + [(n_x (n_x + 1))/2] - R_x \qquad (2)$$

$$U_y = n_x n_y + [(n_y (n_y + 1))/2] - R_y \qquad (3)$$

where:
-nx is the number of observation or participants in the first group;
-ny is the number of observations or participants in the second group;
-Rx is the sum of the ranks assigned to the first group; and
Ry is the sum of the ranks assigned to the second group.
The level of significance was set at an alpha level of 0.05. The data were analyzed using Statistical Package for Social Science (SPSS) version 25.

RESULTS AND DISCUSSIONS

Sociodemographic, Farming, and Business Characteristics

The farmers' sociodemographic characteristics are presented in Table 1. Of the respondents, 96.1% were men and 3.9% were women. The average age was 46.

The major ethnicity (96%) was Javanese. In terms of education, most of them had attended only elementary school. Arabica farm ownership was 98% private.

A total of 84.3% farmers had secondary jobs, and the average farming experience was seven years.

Table 2 presents the characteristics of arabica farming in the sample. The farmers' crop failure rate was 80.4% due to parasites, plant disease (*Hemileia vastatrix*), and drastic climate change in the farming area, all of which had a tremendous negative impact on quality production for the export market. Of the farmers, 86.3% sold red cherry coffee beans.

Table 1. Socio-demographic statistic of farmers

Socio-demographic	Number	Mean
Sex ratio (%)		
Male	96.1	-
Female	3.9	-
Age (years)	-	45.7
Ethnicity (%)		
Javanese	96.1	-
Bataknese	2	-
Indigenous	2	-
Education (%)		
Elementary school	54.9	-
Junior high school	29.4	-
High school	15.7	-
Land ownership (%)		
Own land	98	-
Lease	2	-
Secondary job (%)		
No	15.7	-
Yes	84.3	-
Farming experience (years)	-	7
Number of observations: 51		

Source: Own field survey, 2020.

This type is the most valuable and is classified as grade A, with an average price of IDR 8,500. The second most valuable grade is a mix of green and red cherry, which are sold to local powdered coffee mills and local coffee shops in Jambi Province. This type is priced at an average of IDR 7,088, much lower than that for grade A. Most farmers gathered information on fluctuating prices from the cooperative (94.1%). Around 5.9% of farmers sold their produce to entities outside the collective, mostly to powdered coffee mills. This highlights their vulnerability to pricing decisions made by these mills compared with other farmers who get price information from official institutions. Cooperative farmers showed increased confidence in anticipating the price because 94% gained price information from the cooperative. The reason was that not all farmers could produce red cherry coffee beans to fulfil the cooperative's quality requirements and searched for options to sell crops not accommodated by the cooperative; thus, they sought price information outside the cooperative anticipating that their crop could not meet the cooperative's quality requirements of grade A (red cherry).

Table 2. Farming characteristics

Characteristic	Number	Mean	Std. dev.
Crop failure (%)			
Ever	80.4	-	-
Never	19.6	-	-
Form of coffee sold (%)			
Red cherry	86.3	-	-
Mix of green and red cherry logs	13.4	-	-
Price information (%)			
From cooperative	94.1	-	-
From others	5.9	-	-
Sales destination (%)			
Cooperative	94.1	-	-
Powdered coffee mill	5.9	-	-
Farmer association (%)			
Joined	54.9	-	-
Not joined	45.1	-	-
Price determination (%)			
Cooperative	94.1	-	-
Others	5.9	-	-
Coffee varieties (%)			
Sigarar utang	60		
Andung sari	20		
P-88	20		
Farm size (ha)	-	1.1	1.1
Employees (no.)	-	3	1.34
Production (kg/ha)	-	212	195.5
Harvest numbers (year)	-	22	3.4
Certified seed applied (%)	3.9		
Intercropping applied (%)	90.2		
Number of observations: 51			

Source: Own field survey, 2020.

Consistent with the literature, we found that farmer cooperatives were unable to buy and market their members' yield because its poor and unstable quality, in most cases, was detrimental to their members themselves and small businesses in the area [16]. Moreover, the actual volume purchased by the cooperative was limited due to financial constraints [14]. The results showed that 54.9% of farmers joined farmers' associations, and cooperatives determined the market price (94.1%). The average farm size was small, less than 2 hectares in size. Most cultivators had no determined land size for coffee farming and conducted inter-cropping to supplement their income (90.2%).

The ownership cooperative comprised a group of people, each owning shares. The cooperative has 25 male and 4 female farmer associations across 22 villages and five subdistricts. The land area covered is over 300 hectares, with 72 laborers coming from local communities. The cooperative characteristics are shown in Table 3.

Table 3. Cooperative's characteristic

Characteristics	Description
Ownership	Group
Male Farmer Associations	25
Female Farmer Associations	4
Villages covered	22
Subdistricts covered	5
Land area (ha)	310
Established (year)	2016
Employees (no.)	72
Farmer members (no.)	514
Height of planted land (m above sea level)	1,300–1,600

Source: Own field survey, 2020.

The cooperative focuses on the export market with 7 tons/month production capacity, and only a small portion of production goes to the domestic market (0.7 ton/month). The average export prices obtained were IDR 80,000, with IDR 65,000 for the domestic market (Table 4).

Table 4. Cooperative Business Activity

Characteristics	Market description	%
Export (t/month)	7	-
Domestic (t/month)	0.7	-
Export price (IDR)	80,000	-
Domestic price (IDR)	65,000	-
Price purchase (IDR)	8,500	-
Price fixing (farmers)	By cooperative	100
Price fixed (buyer)	By buyer	100
Coffee form	Red cherry	100
Coffee form for export	Dry green bean	100
Coffee form for domestic market	Green bean, roasted	30–70
Export market	-	90
Domestic market	-	10

Source: Own field survey, 2020.

The cooperative runs a few businesses related to coffee tourism (educational tour of arabica coffee farming and cottage rentals in the farming area).

Cost and Profitability of Direct Selling

The cost and profitability analyses result of direct selling among the cooperative and their farmers are presented in Table 5.

The results highlighted that the average fixed cost of total production in a one-year cycle of arabica coffee for the cooperative was IDR 8,557,500, and for farmers, it was IDR 326,216; the average costs per kilogram of arabica coffee produced for the cooperative and farmers were IDR 66,173 and IDR 4,094, respectively.

The proportions of variable and fixed costs for the cooperative were 98.15% and 1.85%, respectively, whereas for farmers, they were 79.51% and 20.49%, respectively. There was a statistically significant difference between the cooperative and its farmers in terms of the total variable cost ($p = 0.02$).

The main cost components for the cooperative were red cherry arabica coffee purchase and hired labour (IDR 267,750,000 and IDR 108,000,000, with proportions of 57.80% and 23.32%, respectively).

For farmers, the main costs were hired labour and fertilizer combined with herbicide, with values of IDR 501,176 and IDR 300,000, 31.47% and 18.84%, respectively. The average total cost for the cooperative was IDR 463,212,500, and for farmers, it was IDR 1,592,392.

The results showed that the total cost difference between the cooperative and farmers was statistically significant ($p = 0.00$). Cooperative activities requiring labour included processing red cherry arabica beans, drying green beans, and shipping, which comprise the labour-intensive stage of preparing coffee for the market.

Meanwhile, the labour-intensive stage for farmers is concentrated only on peak harvesting. For the cooperative, 72 laborers were required for buying and processing, which implied excessive labour. For farmers, hired labour is not a huge requirement, with an average need for three people.

Labour is also only used during peak harvest time, and hired laborers' sole responsibility is picking red cherries. Coffee cultivation and harvesting are usually carried out by the farmers themselves because arabica coffee farmers are mostly small scale with farms of less than 1.12 hectare. There was a statistically significant difference in terms of depreciation (p =0.03) and hoe values (p =0.000).

Table 5. Average cost and profitability of direct selling arabica coffee among cooperative and its farmers

	Cooperative				Farmers				P-Value
	Quantity	Price/Unit (IDR)	Cost (IDR)	Share (%)	Quantity	Price/Unit (IDR)	Cost (IDR)	Share (%)	
Variable Cost									
Tools									
Pulper Machine	2	8,000,000	16,000,000	3.45					
Huller Machine	1		6,000,000	1.30					
Computer	1		7,000,000	1.51					
Continuous Sealer	1		4,000,000	0.86					
Scale (for 5kg)	1		150,000	0.03					
Moisture test equipment	1		7,500,000	1.62					
Hoe	1		98,000	0.02	2	98,000	196,000	12.31	0.000*
Bucket	1		57,000	0.01	1		57,000	3.58	1.000
Production and material									
Red Cherry Coffee (Kg/Month)	38,250	7,000	267,750,000	57.80					
Electricity (Kwh/month)	135	1,111	150,000	0.03					
Water (m3/month)	88	2,841	250,000	0.05					
Gunny Sack	100	3,000	300,000						
Plastic Sack					10	1,200	12,000	0.75	
Tarp	1		2,400,000	0.52					
Fertilizer							300,000	18.84	
Herbicide and Pesticide							100,000	6.28	
Hired Labor (People/Month)	72	1,500,000	108,000,000	23.32	3	167,059	501,176	31.47	0.087
Marketing and Shipping			35,000,000	7.56					
Transportation							100,000	6.28	
A. Total variable cost			454,655,000	98.15			1,266,176	79.51	0.022*
Fixed Cost									
Depreciation			8,157,500	1.76			257,000	16.14	0.033*
Repair and Maintenance (Month)			100,000	0.02			30,000	1.88	0.114
Business permit			300,000	0.06					
Rent of Land (Ha/month)							39,216	2.46	
B. Total fixed cost			8,557,500	1.85			326,216	20.49	0.127
C. Cost production (D/E) & (D/F)			66,173				4,094		0.089
D. Total Cost (A+B)			463,212,500				1,592,392		0.005*
E. Yield (Kg/Month)							389		
F. Sales Quantity (Kg/Month)			7,000						
G. Sales Price			80,000				8,500		0.069
H. Gross Profit (F*G) & (E*G)			560,000,000				3,306,500		0.317
I. Net Profit (H-D)			96,787,500				1,714,108		0.089
J. Cost-Benefit Ratio (H/D)			1.21				2.08		0.764
K.ROI (H-D)/D x 100%			20.89				107.64		0.089

* Significant at $p < 0.05$, Mann-Whitney test for the difference between all inputs
Source: Authors' data calculation, 2020.

The results also showed that labour cost was the cooperative's second major cost item at 23.32%. A similar finding was reported by Utami et al [31], who found that labour cost at

Tirto Kencono cooperative, Tanggamus Regency, Indonesia, was also the second major variable cost, at 33.56%. The cooperative's biggest cost item was buying red cherry arabica beans from farmers, with a value of IDR 267,750,000 (57.80%). Other costs for the cooperative included repair and maintenance (0.02%) and business permits (0.06%), while for farmers, this included depreciation (16.14%) and repair and maintenance (1.88%). The cooperative's average arabica sales per month in kilograms was 7,000; the farmers' yield per hectare was 389 kg/month. Higher production can be achieved by farmers partly because Mount Kerinci is an active volcano mountain, and the soil in Kerinci Regency is fertile and supports arabica coffee farming. The cooperative's gross and net profits were IDR 560,000,000 and IDR 96,787,500, respectively; for farmers, they were IDR 3,306,500 and IDR 1,714,108, respectively. The rates of return were 1.21 for the cooperative and 2.08 for farmers. The return on investment (ROI) values were 20.89 and 107.64 for the cooperative and farmers, respectively.

The results showed that farmers could earn a 0.87-point higher earnings return than the cooperative. This indicated that net profit generated by the cooperative is large compared with the farmers, but small when considering the incurred total costs.

This differed from farmers' net profit, which covered the cost of production in one season of arabica coffee production, unlike that for the cooperative.

Farmers operate as personal businesses that only fund household needs, unlike the cooperative, which must finance production needs and share the net profit with shareholders; the farmers receive the entire net profit without sharing it with any party. Further, the cost-benefit analysis verified that farmers gain more benefits since their total costs are not as large as those of the cooperative.

The ROI values confirmed that farmers achieve higher profitability from selling directly to the cooperative. From a business institutional perspective, cooperatives are expected to earn higher profits, but this study revealed that the return rate and ROI values for farmers are much higher than that of cooperatives; therefore, our findings break new ground by demonstrating that farmers benefit more with direct marketing schemes.

CONCLUSIONS

This study showed who benefits more from direct marketing schemes based on direct economic surveys in rural Indonesia. It demonstrated that the biggest cost incurred under this scheme was variable cost. We observed a lack of support from external institutions (non-governmental organizations and local government). Based on these results, we suggest that both cooperatives and farmers benefit from cooperation, and local governments should draft policies to reduce variable cost components. Our findings make several contributions to the literature. First, the calculated gross and net profits are large, but statistically, they are not much different between the cooperative and farmers. Second, farmers enjoy more profitability with a higher net return point and ROI than the cooperative. This result can encourage policymakers to consider our novel finding that a direct marketing scheme can be applied to other areas of economic sustainability development in rural Indonesia especially more benefit for small farmers.

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CORRELATION ANALYSIS OF PROFITABILITY IN THE MANAGEMENT SYSTEM OF AGRICULTURAL ENTERPRISES ON THE BASIS OF SUSTAINABLE DEVELOPMENT

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Abstract

The article considers the specifics of ensuring the efficiency of agricultural enterprises on the example of the Volyn region, Ukraine. The need to achieve the appropriate level of profitability as a criterion for the successful operation of agricultural enterprises is identified. The results of the activity of agricultural enterprises of the region according to the criteria of profitability and profitability are analyzed. The correlation-regression model for the definition of the key criteria which express the efficiency of functioning of the agricultural enterprises is constructed.

Key words**:** *agricultural enterprise, management efficiency, profitability level, efficiency of agricultural enterprises*

INTRODUCTION

The specifics of the current stage of transformation of economic relations in the agro-industrial complex of Ukraine involve the formation of an effective and efficient model of enterprise management, which should be focused on improving the profitability of agricultural enterprises. Of course, for a long time, the transformation of economic relations in the agricultural sector took place and the negative aspects of the interaction of agricultural producers with the state, financial institutions, and trade intermediaries. However, the market mechanism has made it possible to establish the proper efficiency of agricultural enterprises, especially after the opening of solvent markets of the European Union for Ukrainian businesses.

However, it should be noted that the construction of an effective management model should provide for the existence of certain criteria that agricultural enterprises must meet in the process of their activities to ensure high efficiency and proper return on capital. As practice shows, the most successful in this aspect are large agricultural holdings, which have sufficient material and financial resources to ensure an adequate level of profitability. At the same time, medium-sized enterprises and small agricultural producers, who are often forced to work through trade intermediaries in the sale of their products, have difficulty achieving high profits. Therefore, ensuring efficient economic activity for such agricultural enterprises requires the definition of the criterion of this efficiency, the achievement of which will allow them to count on the appropriate financial return. As practice shows, the key generalized indicator, in this case, is the profitability of economic activity. Accordingly, it is necessary to study the allowable levels of profitability of agricultural enterprises, which provide them with the appropriate level of economic efficiency.

Peculiarities of research of problems of ensuring the increase of efficiency of functioning of the agricultural enterprises consist in a problem of definition of universal criteria of an estimation of their financial reporting. Therefore, most of the work related to this area is aimed at studying the features of ensuring the profitability and profitability of agricultural production. Therefore, a number of studies can be identified, which widely cover the key aspects of ensuring the profitable operation of agricultural enterprises. These include, above all, the work of researchers such as: O. Agres [1], O. Apostolyuk [2], I. Balaniuk [3], O. Binert [4], Y. Chaliuk [5], M. Dziamulych [6-11], Ya. Kostetskyi [14], O. Koval [15], A. Marcuta [17], B. Paskhaver [18], A. Popescu [20-28], T. Shmatkovska [30-32], R. Sodoma [33-35], O. Stashchuk [36-38], I. Yakoviyk [39], Ya. Yanyshyn [40], O. Yatsukh [41], I. Zhurakovska [43] and others.

However, practice shows that relying only on traditional approaches based on the coefficient analysis of the reporting of agricultural enterprises, does not always give an objective answer to achieve the appropriate level of efficiency of their operation through the performance of profitability and profitability. More relevant are the approaches that are based on the definition of relationships between individual indicators of economic efficiency and involve the use of elements of economic and mathematical modelling. Therefore, we consider it appropriate to focus on the implementation of the correlation-regression model of factor analysis of the profitability of agricultural enterprises to determine the main factors of ensuring the efficiency of agricultural production.

MATERIALS AND METHODS

Our study is based on the assessment of the effectiveness and economic feasibility of agricultural enterprises. This assessment is based on the use of not only absolute but also relative indicators, which include a system of profitability indicators.

The economic essence of profitability can be revealed only through the characteristics of the system of indicators. Their general content is to determine the amount of profit from one UAH of invested capital. And because these are relative indicators, they are virtually unaffected by inflation.

The main indicators of profitability, which measure the profitability of enterprises in Ukraine, are the following:

1. Return on assets (R_a) – shows what profit the company receives from each UAH invested in assets:

$$R_a = \frac{P}{A},$$

where:

P – profit remaining at the disposal of the enterprise (net profit);

A – the average value of assets.

This indicator characterizes the efficiency of the property of the agricultural enterprise.

2. Return on investment (R_i) – an indicator that reflects the efficiency of the use of funds invested in the enterprise. This indicator reflects the assessment of the "skill" of investment management:

$$R_i = \frac{P}{E+L_l},$$

where:

P – the total amount of profit for the reporting period;

E – the average amount of equity;

L_l – the average size of long-term liabilities.

3. Profitability of production (R_p), which is directly dependent on the profitability of products and inversely dependent on changes in capital intensity of products.

$$R_p = \frac{P_g}{C_a}, \quad (3)$$

where:
P_p – gross profit;
C_a – the average for the analysed period is the balance of the own and borrowed capital of the enterprise.

This indicator characterizes the profitability of the enterprise in relation to the available financial resources that are at its disposal, i.e. such an indicator is the resource [19].
However, since the specifics of calculating the profitability of agricultural enterprises is characterized by significant deviations of the average values when sampling large data sets of enterprises, to form objective and reliable models of efficiency of agricultural enterprises, we propose to apply a coefficient of variation that allows taking into account differences. the studied population.
The calculation of the coefficient of variation is performed by the following method:

$$V = \frac{\delta}{X_{am}},$$

where:
δ – root mean square deviation;
X_{am} – arithmetic mean of the variation series.

It should be borne in mind that if this figure does not exceed 0.333, the variation of the sign is considered weak, and if more than 0.333 - strong. Accordingly, in the case of strong variation, the statistical population is considered to be heterogeneous, and the average value is atypical, so it cannot be used as a generalizing indicator of this population. The lower limit of the coefficient of variation is zero, and the upper limit does not exist. However, increasing variation of the trait increases its value.
Also, when calculating the coefficient of variation, we have to use the standard deviation. It is defined as the square root of the variance, which, in turn, is defined as follows:

$$D = \frac{\sum(X - X_{am})^2}{N}$$

In other words, the variance will be the mean square of the deviation from the arithmetic mean. The standard deviation determines how much on average the specific indicators of the series deviate from their mean value [29].

RESULTS AND DISCUSSIONS

Within the generally accepted approach to determining economic efficiency as the value of the result per unit of resource spent on it as a generalized final indicator of the efficiency of the agricultural enterprise is the level of profitability (level of profitability), which is the ratio of profit from agricultural sales to its total cost multiplied by 100%. According to the "Forms 50 – Agriculture" in Ukraine for 2019, it can be determined both separately for crop production (line 010) and livestock (line 0130), and in general for agriculture (the sum of lines 010 and 0130). Since the available statistical information for 2019 on "Forms 50 – Agriculture" reflects the performance of only medium and large enterprises, this leads to limited factor analysis of the economic efficiency of agricultural enterprises in the Volyn region.
Factor analysis will begin with the study of variations in the level of profitability in 2019 in graphical form (Fig. 1).
The level of profitability of agricultural enterprises in 2019 fluctuated widely and not only in general in business structures, but also in each organizational and legal form. In 105 enterprises it was lower than 0%, in 372 it exceeded it, and in each form, there was a certain number of both unprofitable and profitable enterprises: in limited liability companies – 54 and 193; in joint-stock companies – 11 and 16; in agricultural production cooperatives – 6 and 25; in private enterprises – 16 and 84; in farms – 6 and 45 and in state enterprises – 9 and 5 [16].
Fig. 1 shows that the maximum value of the level of profitability is achieved in the range from 40.1% to 50%, the mode is 37.4%, which reflects the most frequent level of profitability of the sample. The value of asymmetry $S_к$ = 0.86 and excess $E_к$ = -0.54 indicates a slight right-hand asymmetry.

Indeed, to the left of trend, we have 45% of enterprises, to the right – 42%. The basic properties of the normal distribution law are somewhat violated.

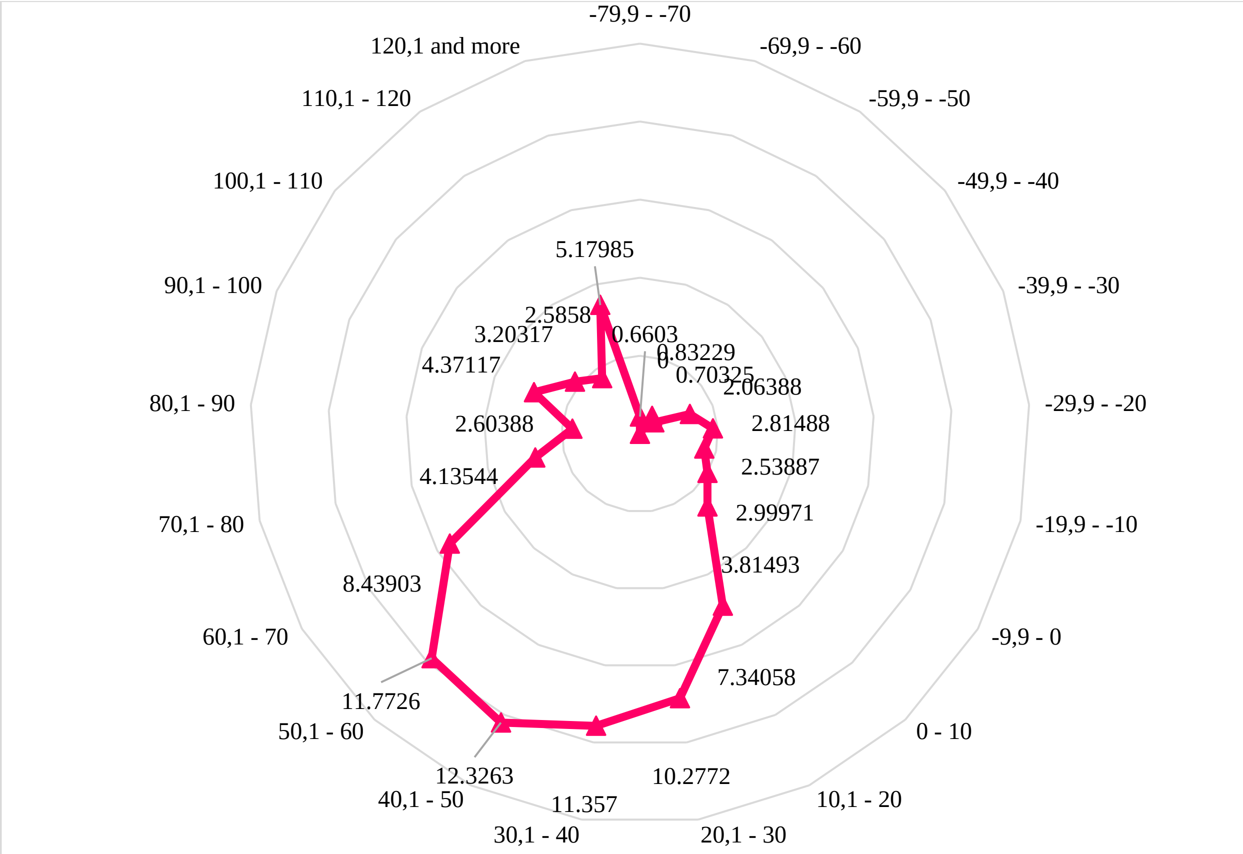

Fig. 1. Distribution of agricultural enterprises of Volyn region of Ukraine by the level of profitability in 2019, %
Source: Own development based on statistical data.

The indicator for the level of profitability of certain forms of management is also characterized by a large variation (Table 1), which does not allow to unambiguously determine the optimal organizational and legal form of entrepreneurship in the region.

However, the results of the study of the spatial variation in the level of profitability of certain forms of entrepreneurship, presented in Table 1, show that the lowest percentage of dispersion of efficiency indicators have farms and limited liability companies, the size of which in both cases does not exceed 70%.

This situation is accompanied by the highest modal and average values of profitability in these structures, which gives grounds to conclude about a more stable position of these forms of management, compared to others, in the agricultural market of the region.

Table 1. Productivity indicators of research of spatial variation of the level of profitability of organizational and legal forms of Volyn region of Ukraine

Legal entity type	Modal value of the level of profitabi-lity, %	Average level of profitabi lity, %	Coeffi cient of variati on, %
Limited Liability Company	57.8	26.2	65.6
Joint stock company	50.2	24.8	76.4
Agricultural production cooperative	43.4	18.35	88.3
Private enterprise	49.4	22.6	81.4
Farm	55.05	30.3	63.6

Source: Own development based on statistical data.

The instability of socio-economic conditions for the functioning of agricultural enterprises, the inconsistency of government reform measures in the development of a market economy cause significant fluctuations in the indicator of economic efficiency of production – the level of profitability. This indicator primarily depends on internal development factors, in particular, on the level of resource provision [12; 42].

To a large extent, the formation of the dynamics of economic efficiency in various organizational and legal forms in the Volyn region was influenced by the negative dynamics of resource provision of surveyed farms, which is a consequence of reduced investment activity of agricultural enterprises as a result of deteriorating financial and economic condition. To identify the relationship between the level of profitability and indicators of resource supply of agricultural enterprises in terms of groups of the level of profitability of the Volyn region, an effective grouping was carried out. As a result of the statistical combination of groups of the level of profitability of enterprises, a very high level of influence on the performance of all three types of resources, namely the degree of provision of enterprises with land, labour, and capital resources. With the growth of the average size of an agricultural enterprise, the indicators of the obtained level of profitability increase. These indicators of resource supply are both indicators of the size of agricultural enterprises and the level of concentration of production.

One of the reliable statistical patterns identified by domestic and foreign scientists is the positive impact of production growth on economic efficiency [13]. In order to identify such a relationship and its form in the agricultural production of the Volyn region, a multiple correlation-regression analysis was performed, the results of which are shown in Table 2.

The coefficient of determination between performance and factor characteristics in the whole set of agricultural enterprises is 0.96. It is highest in limited liability companies, and much lower in other forms of business management. Since the factor of the scale of production in limited liability companies in 2019 acted as clearly as possible, we can conclude that the highest level of adaptation of this organizational and legal form of agricultural enterprises to modern market economy requirements in the study region.

Each business form, according to the current legislation of Ukraine, has different levels of authoritarianism and responsibility of the head for the final results of management, which, of course, affects the organization of agricultural activities and affects its economic efficiency. We consider this difference to be significant, and therefore we will focus on the peculiarities of the organization and coordination of agricultural production in the business structures of the region.

Table 2. Statistical characteristics of the dependence of the level of profitability of agricultural production on the indicators of resource provision of agricultural enterprises of Volyn region of Ukraine in 2019

Legal entity type	Regression equation	Coefficient of determination
Agricultural enterprises, total	$У = -90.31+0.0098x_1 +0.0079x_2+2.0388x_3$	0.96
Limited Liability Company	$У = -65.318+0.0085x_1+ 0.024x_2–1.0569x_3$	0.92
Joint stock company	$У = -59.628–0.0036x_1– 0.0036x_2+0.087x_3$	0.66
Agricultural production cooperative	$У = -40.131–0.019x_1+ 0.0019x_2–0.103x_3$	0.65
Private enterprise	$У = -70.4+0.0446x_1+ 0.0052x_2+0.0243x_3$	0.69
Farm	$У = -23.447–0.011x_1+ 0.0104x_2+1.487x_3$	0.90
State Enterprise	$У = -34.014+0.005x_1+ 0.0042x_2–0.147x_3$	0.83

Source: Own development based on statistical data.

An important factor in the efficiency of agricultural enterprises of all organizational and legal forms is the process of organizing an agrarian business as an indicator of its competitiveness. Domestic statistics of the region allow us to track the dependence of the level of profitability on the main competitive indicators at the level of administrative districts. With the help of correlation-regression analysis, we will study the influence of certain factors that are related to the peculiarity of the organization of agricultural production on its efficiency in agricultural enterprises. We use information about the activities of business structures of 20 administrative districts of the Volyn region, which did not include highly specialized horticultural enterprises, poultry farms, and pig farms. That is, the activity of enterprises with the traditional organization of agricultural production on medium and large tracts of land resources is analyzed.

Effective feature: efficiency criterion – the level of profitability of agricultural production (Ух). The influence of the following factors on it was considered:

– average annual value of assets per 1 ha of agricultural land, UAH (x_1);
– production costs per 1 ha of agricultural land, UAH (x_2);
– administrative costs per 1 ha of agricultural land, UAH (x_3);
– average monthly cash receipts from sales of agricultural products, thousand UAH (x_4) (determines the size of turnover);
– average monthly salary of one average annual employee, UAH (x_5);
– labour costs per 1 hectare of agricultural land, man-hours (x_6);
– the share of costs for the production of livestock products in the structure of production costs of agricultural products, % (x_7).

The obtained regression equation has the form:

$$У_x = -27{,}021 – 0{,}0033X_1 + 0{,}0206X_2 + 0{,}044X_3 + 0{,}0058X_4 + 0{,}007X_5 – 0{,}006X_6 + 0{,}081X_7$$

First of all, we note that on the basis of paired correlation coefficients between performance and individual factors, there is no impact on the level of profitability of agricultural production labour costs per 1 hectare of agricultural land (x_6) and the importance in the economy of livestock enterprises (x_7).

The lack of an obvious link between labour costs per 1 hectare of agricultural land and the level of profitability of production is associated with a range of problems in the use of labour resources in agriculture: irrational use of existing production staff, which does not increase productivity; with shortcomings in the accounting of labour costs, especially in the case of the use of employees involved in seasonal work; high differentiation of living and tangible labour in the production of various types of products, which is associated with the differentiation of the level of its mechanization; as well as seasonal fluctuations in the employment of many workers.

As you know, the production of livestock products in most companies is unprofitable and therefore significantly curtailed. A significant number of enterprises in the region do not produce it at all. This situation is extremely irrational from the standpoint of public interest, as it does not guarantee a reliable supply of the region with meat and dairy products of regional production. However, it does not significantly affect the overall level of profitability of agricultural enterprises: due to reduced livestock production is the release of some economic resources (fixed and working capital, primary production workers, and even land for fodder crops), which increases the production of more profitable crops.

The influence of other factors from our study is essential. This is evidenced by the multiple correlation coefficient between them and the resultant trait, which is 0.95, and other parameters used for statistical testing of hypotheses.

The greatest link is between the performance trait and production costs per hectare of agricultural land. The correlation coefficient between them is 0.92. The parameters of the equation show that with the growth of production costs per 1 ha of land per 1 UAH, we can expect an increase in the level of profitability of production by 0.0206%. In other words, per 1 hectare of land area with an increase in costs by 1 UAH, we can expect an increase in revenue by UAH 1.54, which indicates the full payback of production costs. This indicates a fairly high level of technology in a significant number of enterprises in the region used in agricultural production.

There is also a fairly high relationship between the performance indicator and the average monthly salary of one average annual employee. The correlation coefficient between them is 0.82. That is, with an increase in the employee's monthly salary by UAH 1. you can expect an increase in profitability by 0.006%. This indicates the activation of work motivation in those enterprises of the Volyn region that seek high results, the main form of which is the material incentives for employees.

There is a direct relationship between the level of administrative costs per 1 ha of land, the level of average monthly cash receipts from sales, and the studied performance indicator. However, the feedback between the value of assets per unit area and the level of profitability of agricultural production is unexpected. The main reason for this is the irrationality of assets. To date, a significant number of fixed assets of agricultural enterprises in the region, both physically and morally, are worn out, in addition, many types of equipment are defective, and empty livestock facilities are not used at all in agricultural production.

Thus, the results of correlation and regression analyzes showed that the most important factors of economic efficiency of agricultural production are: 1) the size of the enterprise; 2) remuneration as a factor motivating work;
3) production intensity (the number of costs and assets per unit area). Therefore, we analyze the level of these factors in the formation of economic efficiency of economic activity in profitable and unprofitable groups of enterprises.

The size of profitable enterprises of each organizational and legal form of management is greater than unprofitable - by the area of productive land by an average of 7.6%, the value of assets – by 43%, the number of employees – by 23.5%, and the amount of cash flow from sales – on average by 58.2%. St. 63 of the Commercial Code of Ukraine, it is established that enterprises with an average number of up to 50 people and the amount of sales revenue up to 500 thousand euro are small [43]. These parameters are almost entirely consistent with the size of unprofitable enterprises of various forms of management in the Volyn region, which can be considered small, and profitable – medium. However, judging objectively, the size of unprofitable enterprises is sufficient for the effective use of machinery in field mechanized work, because, with a 10-field crop rotation and the size of the cultivated contour of 0.5 fields, the working length of the drive can approach 1,000 m. But profitable enterprises of all forms, without exception, stimulate employees much better. Their annual wages are on average 1.3 times higher than unprofitable, although its share in costs and cash inflows of most of them is inferior to unprofitable. Indicators of production intensity are somewhat contradictory. If the value of assets per 1 ha of agricultural land profitable enterprises is inferior to unprofitable (from 1.1 to 34.5%), then the annual amount of production costs for the same area and the cost of mineral fertilizers per 1 ha of arable land is more than 1.5 times on average exceed unprofitably. However, as the regression equation is shown such a situation is quite logical for profitable enterprises in Volyn.

CONCLUSIONS

Thus, the results of studies of internal factors of the level of profitability of agricultural enterprises of the Volyn region showed that the implementation of economic activity of profitable enterprises is different from unprofitable. First, profitable enterprises are much larger in terms of resources, which allows them to actively enjoy the benefits of increasing returns to scale. Secondly, profitable enterprises implement a more effective system of labor incentives, understanding the simple postulate of the economy: if the salary of employees does not change in the direction of increasing its dependence on the level of efficiency of their work, then no practical effect can be expected. Third, unprofitable enterprises choose a non-intensive way of doing business, because their agricultural business is characterized by a low level of additional investment in agricultural production in terms of reduced efficiency of use of assets available on balance sheets.

Thus, we can conclude that to increase the efficiency of enterprises in the Volyn region should first talk about improving the level of management, namely the application of advanced principles of formation and strengthening of the material and technical base, development, and implementation of new approaches to efficient use of labor, rationalization of internal land use.

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VARIATION OF SOME PRODUCTION PARAMETERS IN WHEAT IN RELATION TO FOLIAR BIOSTIMULATOR, CULTIVARS AND CROPS SITE IN ROMANIA

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Abstract

The study evaluated the variation of some wheat production parameters, in relation to the Super Fifty foliar biostimulator, different cultivars and crop locations. Testing experiments were performed in the area of Bazos (Baz), 'Altigo' wheat cultivar, Gataia (Gat), 'Glosa' wheat cultivar, and Lovrin (Lov), 'Alex' wheat cultivar, Timis County; in the area of Caracal (Car), 'Izvor' wheat cultivar, Caracal County; and in the area of Secuieni (Sec), 'Glosa' wheat cultivar, Neamt County. The Super Fifty (SF) product, based on algae extract, was used according to the manufacturer's recommendations (BioAtlansis). Under the influence of the Super Fifty biostimulator, the production (Y) had values between 5,280.00 kg ha^{-1} in the conditions from Lovrin, 'Alex' cultivar, and 8,565.75 kg ha^{-1} in the conditions of cultivation from Bazos, 'Altigo' cultivar. The protein content (Pro) varied between 10.30% in the conditions from Secuieni, 'Glosa' cultivar, and 15.90% in the conditions from Caracal, 'Izvor' cultivar. The gluten content (Glt) varied between 20.80% in the conditions from Secuieni, 'Glosa' cultivar, and 36.50% in the conditions from Lovrin, 'Alex' cultivar. In the PCA - Correlation Matrix, PC1 explained 53.704% of variance, and PC2 explained 32.806% variance, on the values of the recorded quantitative and qualitative production parameters. Regarding the production increase (ΔY), the protein increase (ΔPro) and the gluten increase (ΔGlt), in the PCA - Correlation Matrix, PC1 explained 69.848% of variance, and PC2 explained 27.316% variance.

Key words: *crops site, foliar biostimulator, PCA-Correlation Matrix, wheat cultivars, yield parameters*

INTRODUCTION

In classical-conventional agricultural systems, soil is the main source of nutrients for crop plants [19], [25], [37].

The application of fertilizers to the soil, with incorporation, by different methods and techniques, is the main way of supplementing nutrients for plants of crops with nutrients [10], [43], [8].

Nutrient management has an important role in agricultural technologies due to the influence of mineral elements to the metabolic processes and substantial contribution to the formation of agricultural production and its quality [15], [9], [33], [21], [36].

Foliar fertilization is a fast and efficient way of supplementing nutrients, with favorable effects in directing plant nutrition [18], [12], [32], [1], [28]. Foliar fertilization can be associated with phytosanitary treatments (various pesticides), which represent advantages regarding the application costs, the volume of agricultural works and the effectiveness of the treatments [13], [5].

Products based on natural extracts, with a role in plant nutrition and as activators of metabolic processes are of high interest for plant production systems in terms of production quality, environmental protection, and capitalization of natural resources in agricultural production processes [42], [3], [4], [35], [39].

Such products, such as natural extracts, have a high importance especially in ecological, biological, organic, biodynamic agriculture systems, but also for conventional agricultural systems [30], [44], [11].

In the category of natural extracts with use in foliar treatments for crops, different categories of products are used, with specific active principles, in relation to crop plants and for the purpose pursued [6], [16], [27], [14].

Products based on algae extracts are of

particular interest in agriculture, due to the content of minerals, but especially of specific bioactive compounds, which makes it possible to prepare biofertilizers and biopesticides, with use for conventional agriculture but also for organic agriculture [26], [7], [4], [31], [40].

The present study evaluated the variation of production, protein and gluten in several wheat cultivars in five different locations, under the influence of the Super Fifty foliar biostimulator based on algae extract.

MATERIALS AND METHODS

The study evaluated the variation of production and quality elements in different wheat cultivars under the influence of the foliar biostimulator Super Fifty (SF) and cultivation sites.

Testing experiments were performed in the area of Bazos (Baz), Gataia (Gat) and Lovrin (Lov), Timis County, in Caracal (Car), Caracal County, and in Secuieni (Sec), Neamt County.

The biological material was represented by the 'Altigo' wheat cultivar (Bazos test field), the 'Glosa' wheat cultivar (Gataia test field), the 'Alex' wheat cultivar (Lovrin test field), the 'Izvor' wheat cultivar (Caracal test field) and the ' Glosa ' wheat cultivar (Secuieni test field).

The product Super Fifty (SF), based on algae extract, was used, according to the recommendations given by the manufacturer (*Bio*Atlansis) [2]. The experiments were organized under appropriate conditions of production technology.

Production (Y, kg ha^{-1}), protein content (Pro, %) and gluten content (Glt, %) were evaluated. Production increase (ΔY, kg ha^{-1}), protein increase (ΔPro, %) and gluten increase (ΔGlt, %) were calculated, under the influence of Super Fifty treatment.

In order to evaluate the increase generated by the Super Fifty (SF) product, the analysis and interpretation of the results was made in relation to the untreated variant, within each wheat cultivar and study location.

PCA was used to discriminate the source of variance, versus treatment (SF), location and wheat cultivar and correlation of production parameters.

The analysis and processing of the obtained results, for the three production parameters taken into study (Y, Pro, and Glt) was done with the statistics module from the EXCEL application, and with the PAST software [17].

RESULTS AND DISCUSSIONS

The application of the Super Fifty foliar biostimulator (SF) to wheat, in the five cultivation locations, led to yields (Y) between 5,280.00 kg ha^{-1} in the conditions of Lovrin, 'Alex' cultivar, and 8565.75 kg ha^{-1} in the conditions of culture from Bazos, 'Altigo' cultivar. The protein content (Pro) varied between 10.30% in the conditions from Secuieni, 'Glosa' cultivar, and 15.90% in the conditions from Caracal, 'Izvor' cultivar.

The gluten (Glt) content varied between 20.80% in the conditions from Secuieni, 'Glosa' cultivar, and 36.50% in the conditions from Lovrin, 'Alex' cultivar. The values of production (Y) and of the studied quality indices (Pro, Glt) are presented in Table 1.

Table 1. The values of the production parameters in relation to the wheat cultivar and crops location, under the influence of the foliar biostimulator Super Fifty

Location Cultivar Parameter	Control (Ct)	Fertilized variant Super Fifty (SF)	Differences (%)
	Y (kh ha^{-1})		
Baz-Altigo-Y	7,763.16	8,565.75	110.34
Gat-Glosa-Y	6,624.00	6,980.00	105.37
Lov-Alex-Y	4,960.00	5,280.00	106.45
Car-Izvor-Y	5,594.00	6,537.00	116.86
Sec-Glosa-Y	5,539.00	6,430.00	116.09
	Pro (%)		
Baz-Altigo-Pro	12.70	13.00	102.36
Gat-Glosa-Pro	15.00	15.40	102.67
Lov-Alex-Pro	13.80	14.20	102.90
Car-Izvor-Pro	15.90	15.90	100.00
Sec-Glosa-Pro	10.00	10.30	103.00
	Glt (%)		
Baz-Altigo-Glt	24.60	26.00	105.69
Gat-Glosa-Glt	34.40	35.50	103.20
Lov-Alex-Glt	33.50	36.50	108.96
Car-Izvor-Glt	24.30	24.40	100.41
Sec-Glosa-Glt	19.10	20.80	108.90

Source: Original data from test fields.

The ANOVA test highlighted the presence of the variance in the data set regarding the studied production parameters (Y, Pro, Glt), and the statistical safety of the results (F>Fcrit, p<0.01, for Alpha=0.001).

The production increase registered, in statistical safety conditions (p = 0.0078, t-test), between the variants treated with the SF biostimulator and the control variants, in the five test locations is shown in Figure 1.

The Super Fifty (SF) biostimulator generated production increases (ΔY) of 802.59 ka ha^{-1} under the cultivation conditions of Bazos (Baz), 'Altigo' wheat cultivar; 356.00 kg ha^{-1} under the conditions of cultivation from Gataia (Gat), 'Glosa' wheat cultivar; 320.00 kg ha^{-1} under the conditions of cultivation from Lovrin, 'Alex' cultivar; 943.00 kg ha^{-1} under the conditions of cultivation from Caracal, 'Izvor' cultivar; 891.00 ka ha^{-1} in the conditions of culture from Secuieni, 'Glosa' cultivar.

In the case of protein content, the increase (ΔPro) generated by the Super Fifty (SF) product is represented in Figure 2.

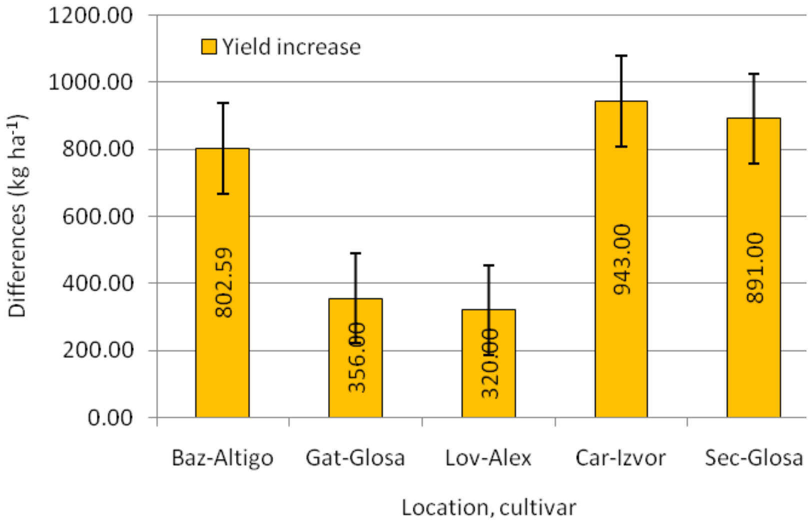

Fig. 1. Production increase (ΔY) generated by the biofertilizer Super Fifty in wheat testing locations, different cultivars

Source: Original data, resulted by calculation.

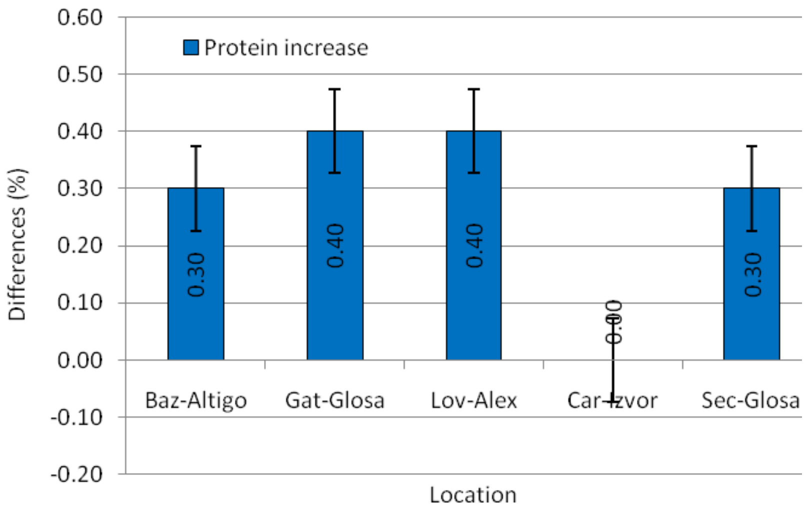

Fig. 2. Protein increase (ΔPro) generated by the biofertilizer Super Fifty in wheat testing locations, different cultivars

Source: Original data, resulted by calculation.

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Although with low values, the increase of the registered protein content presented statistical safety (p = 0.0189, t-test).

The biofertilizer Super Fifty (SF) generated increases in protein content (ΔPro) of 0.30% in the cultivation conditions of Bazos (Baz), 'Altigo' wheat cultivar; 0.40% in the conditions of culture from Gataia (Gat), 'Glosa' wheat cultivar; 0.40% in the conditions of culture from Lovrin, 'Alex' wheat cultivar; 0.30% in the culture conditions from Secuieni, 'Glosa' wheat cultivar. No increases in protein content were recorded under the Caracal culture conditions, 'Izvor' wheat cultivar.

In the case of gluten content, the increase (ΔGlt) generated by the Super Fifty (SF) product, in statistical safety condition (p = 0.0359, t-test), is represented in Figure 3.

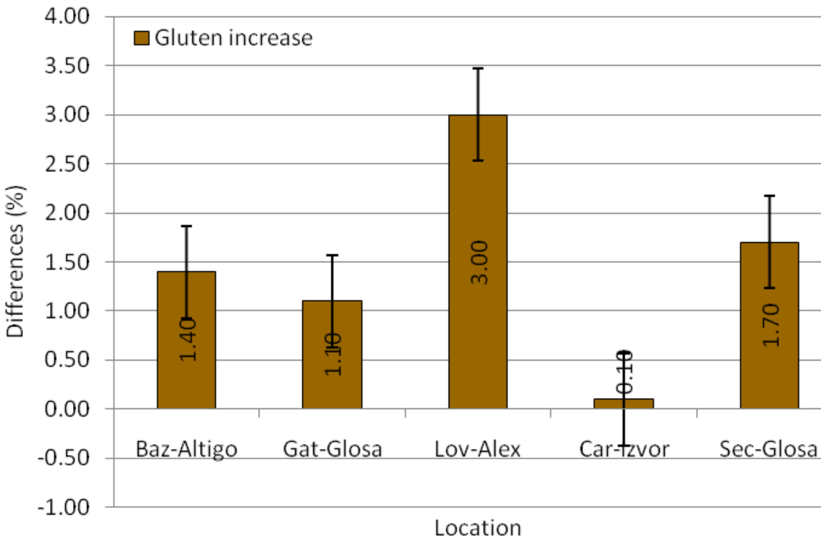

Fig. 3. Gluten increase (ΔGlt) generated by the biofertilizer Super Fifty in wheat testing locations, different wheat cultivars
Source: Original data, resulted by calculation.

The biofertilizer Super Fifty (SF) generated increases in gluten content (ΔGlt) of 1.40% in the cultivation conditions of Bazos (Baz), 'Altigo' wheat cultivar; 1.10% in the conditions of culture from Gataia (Gat), 'Glosa' wheat cultivar; 3.00% in the conditions of culture from Lovrin, 'Alex' wheat cultivar; 0.10% in the conditions of culture from Caracal, 'Izvor' wheat cultivar; 1.70% in the culture conditions from Secuieni, 'Glosa' wheat cultivar.

Considering the level of evaluated parameters (Y, Pro, Glt) on the background of SF treatment, in relation to wheat cultivars and crop locations, the Correlation matrix within PCA led to the diagram in Figure 4. PC1 explained 53.704% of variance, and PC2 explained 32.806% variance, on the absolute values recorded at quantitative and qualitative production parameters.

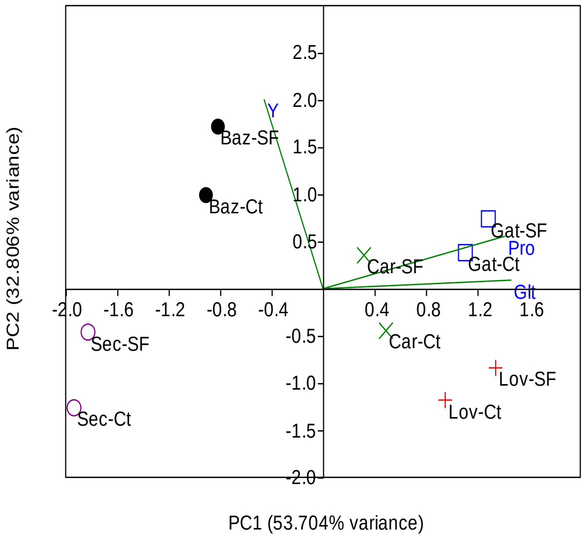

Fig. 4. PCA Correlation matrix diagram on the distribution of experimental cases studied in relation to production parameters analyzed, wheat cultivars, and crop location (Y, Pro, Glt, as bi-plot)
Source: Original graph, general based on experimental data.

In relation to the considered parameters (as bi-plot) in the case of the 'Altigo' cultivar, was found to be correlated with production (Y), as a result of the high values recorded for this analyzed parameter.

The results related to the crops from Lovrin (Lov), 'Alex' cultivar, Gataia (Gat), 'Glosa' cultivar, and Caracal (Car), 'Izvor' cultivar, the correlation with the quality indices (Pro and Glt) was found, according to PCA diagram, Correlation matrix.

The case study on the 'Glosa' wheat cultivar, in the Secuieni location (Sec), was placed on an independent position from the considered elements (Y, Pro, Glt), as a result of the low values recorded for the studied production parameters.

The variation of the production parameters was analyzed in terms of the increase (%) recorded (Y-Increase - ΔY, Pro-Increase - ΔPro, Glt-Increase - ΔGlt) in relation to the cultivars and crop location, under the influence of the SF biostimulator. The PCA - Correlation matrix diagram, obtained is shown in Figure 5.

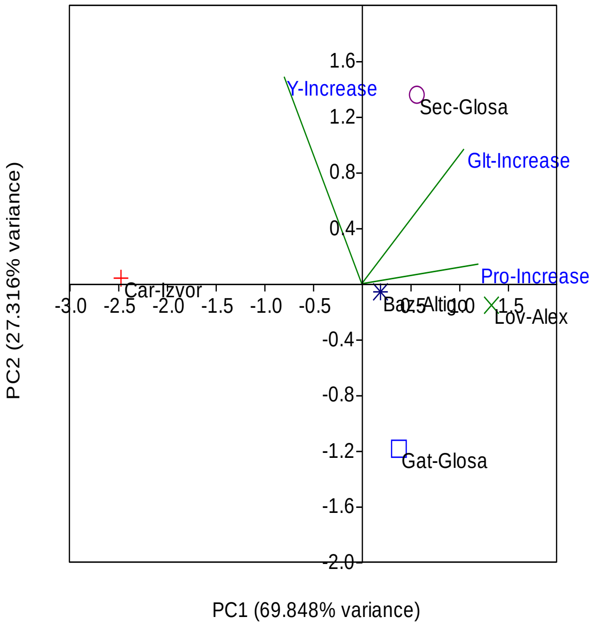

Fig. 5. PCA diagram, Correlation matrix, regarding the distribution of experimental variants in relation to the increase recorded at the analyzed production parameters, wheat cultivar and crop location (ΔY, ΔPro, ΔGlt, as bi-plot; Δ - Increase symbol)
Source: Original graph, general based on experimental data.

PC1 explained 69.848% of variance, and PC2 explained 27.316% variance, based on the values of the production increase (ΔY) and the increase of the quality indices (ΔPro and ΔGlt).

The highest production increase (ΔY) was registered for the 'Izvor' cultivar in the cultivation conditions from Caracal (116.86%), followed by the 'Glosa' wheat cultivar in the cultivation conditions from Secuieni (Sec), Neamt (116.09 %). Due to the wheat cultivation conditions in the two locations, Caracal and Secuieni, the Super Fifty product led to higher production increases compared to the other cultivars and crop locations.

Also, a high increase in production (ΔY) was registered in the case of the 'Altigo' wheat cultivar (110.34%) in the crop conditions from Bazos (Baz). The 'Glosa' wheat cultivar, in the crop condition from Gataia (Gat), Timis, ensured an increase in production (ΔY) of 105.37%, the lowest in the study, which shows the important role of the habitat in the formation of production (interaction genotype x site location).

In the case of protein content, the recorded increase (ΔPro) was generally reduced, by 2.36 - 3.00%. Higher values were recorded in the crop conditions of Lovrin (Lov), the 'Alex' wheat cultivar.

In the case of gluten, the highest increase (ΔGlt) was recorded in the crop conditions of Lovrin (Lov), the 'Alex' wheat cultivar, with a value of 8.96%.

The cluster analysis facilitated the grouping of the cases studied based on the degree of similarity in relation to the evaluated production parameters (Y, Pro, Glt), in statistical safety conditions (Coph.corr. = 0.766). The obtained dendrogram is presented in figure 6.

Within the two formed clusters, it was found the grouping of the variants from Timis County within the C1 caluster; Lovrin, 'Alex' wheat cultivar and Bazos 'Altigo' wheat cultivar with a higher level of similarity, to which was added Gataia, 'Glosa' wheat cultivar. Within the C2 cluster, the variants from Caracal 'Izvor' wheat cultivar and

Secuieni 'Glosa' wheat cultivar were grouped.

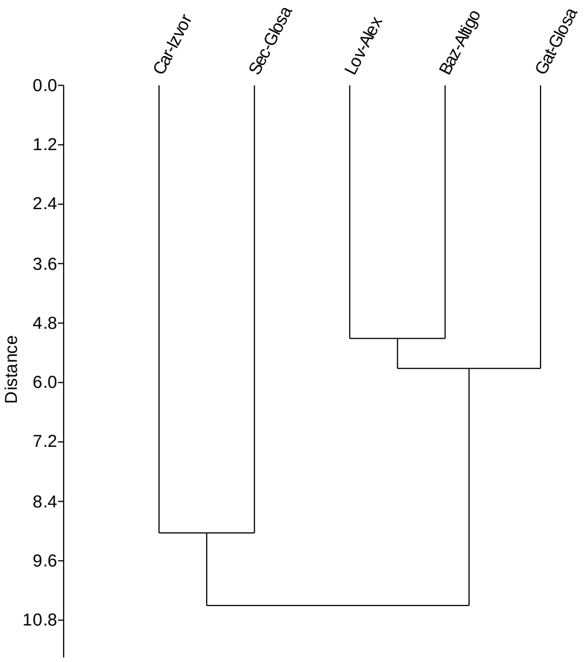

Fig. 6. Grouping of case studies based on similarity (Euclidean distances) in relation to the values of the evaluated production parameters (Y, Pro, Glt) for wheat, different cultivars and crop locations
Source: original diagram, based on the recorded data.

The SDI values also expressed the degree of similarity in the case of the studied cases (wheat cultivars/location) in relation to the values of the production parameters. The highest level of similarity was recorded for the cultivars 'Alex' (Lovrin) and 'Altigo' (Bazos), SDI = 5.1104, followed by 'Altigo' (Bazos) and 'Glosa' (Gataia), SDI = 5.5675.
The variation of the response of different wheat genotypes to foliar treatments has been studied in relation to foliar fertilizers [20], [32], [33], [23] or bioactive products [22], [29].
Complex interactions such as [foliar treatment x genotypes x habitat] in wheat were evaluated in relation to different foliar fertilizers and bioactive substances, in terms of productivity elements (spike, spikelets, grains/spike, etc.), production, grain and straw ionome and quality elements [34], [41], [38], [24].
From the overall analysis of the results, it could be found that the studied varieties had specific receptivity to the treatment and capitalized differently the treatment applied with the foliar biofertilizer Super Fifty (SF), at the level of production (Y) and the quality indices (Pro, Glt) evaluated.

CONCLUSIONS

The Super Fifty foliar biofertilizer (SF) based on algae extract, generated differentiated variation of production (Y), protein (Pro) and gluten (Glt) in the studied wheat cultivars, in relation to the cultivar and the location of the crop.
The highest production, on the background of the treatment with the SF biofertilizer was registered in the culture conditions from Bazos (Baz), Timis County, the 'Altigo' cultivar, and the highest increase under the influence of SF (ΔY, related to the location and variety) was registered under the conditions of Caracal (Car), the 'Izvor' cultivar.
The highest protein (Pro) content was recorded under Caracal conditions, 'Izvor' wheat cultivar, while the highest increase under SF influence (ΔPro, relative to location and cultivar) was recorded under crop conditions from Lovrin, the 'Alex' wheat cultivar, and Secuieni, the 'Glosa' wheat cultivar.
The highest gluten content (Glt) was recorded in the conditions of Gataia, 'Glosa' wheat cultivar, and the highest increase under the influence of SF (ΔGlt, relative to location and variety) was recorded in Lovrin, 'Alex ' wheat cultivar.

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INFLUENCE OF BASIC TILLAGE SYSTEMS AND FERTILIZATION ON PRODUCTIVITY AND ECONOMIC EFFICIENCY OF IRRIGATED CROP ROTATION

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Abstract

The article presents the results of experimental studies on the influence of different methods and depth of basic tillage at the background of organic and organo-mineral fertilization systems on agrophysical properties of soil, its water regime and yields of the cultivated crops. The goal of the study was to scientifically substantiate the optimal parameters of the systems of basic tillage and fertilization in the row short crop rotation in the conditions of irrigation, which guarantee the improvement of effective fertility of the dark-chestnut soils and reduce the chemical load on the environment. Field, laboratory, statistical and computational methods were used in the study conduction. Optimal parameters of agrophysical conditions, both at the beginning of vegetation and before harvesting, were formed by differentiated-1 system of basic tillage where during the crop rotation we alternated shallow plowless tillage for the crops of the Steppe ecological type with combined disc-chisel loosening to 38-40 cm for grain sorghum. As a result, the most favorable conditions for growth, development and crop formation are created by differentiated-1 system of basic tillage under fertilization with by-products and mineral fertilizers application in the dose of $N_{120}P_{60}$ kg/ha. Differentiated by ways and depth system of basic tillage with one para-plowing per the crop rotation contributed to the formation of the highest productivity of the crop rotation: under organic fertilization system – 3.71 t/ha of grain units; under organo-mineral, with the application of $N_{82.5}P_{60}$ per the unit of the crop rotation area – 6.92 t/ha; and under organo-mineral, with the application of $N_{120}P_{60}$ – 8.50 t/ha. The mentioned cultivation technology guarantees obtaining the best profitability level of 110.1%.

Key words**:** *method and depth of basic tillage, agrophysical properties, productivity, crop rotation, irrigation*

INTRODUCTION

Peculiarities of the southern part of the Steppe zone of Ukraine are insufficient natural humidification due to the lack of precipitation under significant potential of heat and solar energy income. Due to such natural features, almost every year there is an acute shortage of moisture, which prevents obtaining the planned level of crops.

Irrigation changes the ratio of moisture and heat in the soil, as well as the intensity of plants' use of radiant solar energy, contributing to the transformation of agriculture into highly productive and sustainable one. At the same time, there is a need to solve the problem of preservation soil fertility on the irrigated lands.

One of the main ways for efficient and sustainable agriculture in the region and reduction of its dependence on the influence of natural and climatic factors is irrigation. Irrigation helps to reduce or even eliminate the water balance deficit, increase crop yields by almost 3-5 times and ensure food security in Ukraine.

Analysis of the yield of major crops on irrigated and non-irrigated lands proves the high efficiency of irrigated agriculture.

In this regard, the relevance of the developed topic is in the need for scientific substantiation of the possibility of using the systems of basic tillage, fertilization, and irrigation.

Given that in the market conditions the final result is a high profit, the constituents of agricultural systems on the irrigated lands should be based on the optimization of material and energy costs and obtaining the highest level of profitability.

Crop yields and the quality of crop products are directly related to the meliorative conditions and soil fertility.

The main measures to achieve this goal are the regulation of biological processes, which take place in soil, as well as its nutrient, water, air and heat regimes. In solving these issues, the systems of basic tillage and fertilization play a leading role [2, 12, 17].

Technogenic resource provision of the agricultural sector should include the development and implementation of the latest intensive farming systems, based on rational low-energy basic tillage, based on the use of tillage tools with different design of working bodies and organic and organo-mineral fertilization systems with the use of crop by-products. An important feature is the effect of such systems of basic tillage and fertilization on the processes, which take place in soil, growth, and development of plants and on the environment in general [1, 10, 11].

This versatility and the degree of the effect of tillage on the dynamics of effective soil fertility, creation of favorable conditions for growth and development of crops, protection of them against harmful effects of weeds, pathogens, pests, erosion have increased over the centuries of agricultural history. Therefore, there is a need to constantly improve existing and develop new most advanced agronomic measures, especially fertilization and tillage systems, considering zonal characteristics and the level of intensification of agricultural production, i.e., a comprehensive approach to the development of fertilization systems and basic tillage to increase the efficiency of irrigated agriculture in general [4, 15, 16].

Recently, there have been discussions in the world between supporters and opponents of tillage minimization. Accumulated over many decades scientific and practical experience convincingly proves the validity of the use, along with moldboard tillage, plowless and surface tillage. In this regard, the data obtained in stationary field experiments are of a great interest.

In a long-term experiment [3] conducted in Hungary, the effect of seven crop sequences and five doses of fertilizers on the stability of corn and wheat yields has been studied. The fertilization system included organic fertilizer (manure or processed crop residues with the addition of NPK) and high levels of NPK fertilizer. The yield of corn and wheat in monocropping in all the cases was inferior to that in the crop rotation. Manure and processing of post-harvest residues (corn stalks, wheat straw) with the addition of NPK were effective fertilizers for corn and wheat. Significantly higher yields were obtained at high levels of NPK fertilizer, especially in the crop rotations, where the proportion of corn or wheat was 50% or higher.

In the early 2000s, 12-year studies in Germany and 4-year-one in Denmark examined different crop rotations, tillage intensity, and pesticide use strategies for yield, humus substitution, and nitrogen balance. The studies have shown that crop yields, energy efficiency in both areas depended significantly on the crop rotation and much less on the intensity of pesticide use or tillage [5].

In the northern regions of the Central Chernozem zone of Russia an effective way of tillage for dark-gray forest soil in the field crop rotation link of "pea-oat mixture-winter wheat-millet" is for the pea-oat mixture – moldboard plowing with PLN 3-35 (control); for winter wheat and millet in terms of agrophysical and biological properties – surface combined tillage with KOS-3.7 [22].

On the sod-podzol sandy soils of Belarus, free enough from weeds, in the fruit-changing crop rotation it is advisable to use instead of traditional moldboard tillage the energy-saving combined tillage system using high-performance chisel and chisel-disk tillage tools, which allow to obtain the same yields, cut the costs, and accelerate the performance of agricultural operations. Plowing should be carried out at least after 2 years, preferably on the bare fallow field, for winter rape, for plowing organic fertilizers during the cultivation of row crops [8].

MATERIALS AND METHODS

In the stationary experiment of the Institute of Irrigated Agriculture of NAAS of Ukraine during 2016-2020 in the 4-field row crop rotation on the dark-chestnut middle loamy soil in the area of the Ingulets irrigation system, five systems of basic tillage (factor A) on the background of organic and two organic and two mineral fertilization systems (factor B) were studied.

Factor A (basic tillage):

(1)The system of multi-depth moldboard plowing with the depth of 14-16 cm for winter wheat and 25-27 cm for soybeans;

(2)The system of multi-depth plowless tillage with the same depth of loosening;

(3)The system of single-depth shallow (12-14 cm) disk tillage for all the crops in the crop rotation;

(4)The system of differentiated tillage with one para-plowing on 38-40 cm per the crop rotation;

(5)The system of differentiated tillage in the crop rotation with one plowing at 18-20 cm per rotation.

Factor B (fertilization system):

(1)Organic fertilization system with the use of by-products.

(2)Organo-mineral system with the application of $N_{82.5}P_{60}$ per 1 ha of the crop rotation area + by-products.

(3)Organo-mineral with the application of $N_{120}P_{60}$ per 1 ha of the crop rotation area + by-products.

The soil of the experimental field is dark-chestnut middle loamy one, and the granulometric composition is coarse-dusty-silty. The humus horizon is 38-40 cm. The content of humus in the soil layer of 0-40 cm is 2.15%, the field capacity of the soil layer of 0-100 cm is 21.5%, wilting point is 9.1%, the content of water-resistant particles is 34.1%, steady-state density is 1.39-1.42 g/cm^3, porosity is 49.2%, water permeability is 1.25 mm/min.

The crops cultivation technology was generally accepted for the irrigated lands of the Southern Steppe of Ukraine, excepting the studied factors.

During the growing season, soil moisture in the layer of 0-50 cm was maintained at the level of not less than 70% FC.

The field experiments were carried out according to the methods of experimental work, special methods of land reclamation, irrigated agriculture, soil science, methodical recommendations, and guidelines [14, 20].

Regional varieties and hybrids of the crops, listed for the Steppe zone in the "State Register of Plant Varieties Suitable for Dissemination in Ukraine", were sown [13].

The depth of tillage was determined from the edge of the uncultivated furrow to its bottom with the help of a furrow-ruler, and at least fifty excavations were made in each section. After determining the average depth at each section of the experiment, the coefficient of flatness of the tillage was determined and evaluated by the five-point scale [6].

The density of the arable layer was determined by the method of cutting rings [7], water permeability – by the method of floodplains in a three-hour exposure with subsequent determination of the depth of soaking [6]. Soil moisture was determined by gravimetric method [20]. Total water use of the crops – by the method of water balance without considering the recharge of groundwater [21].

The total water use for the growing season, as well as for the separate interphase periods of the crops in the crop rotation, was determined by the method of water balance by the formula (1) [19]:

$$\mathbf{E = M + O + (W_h - W_k)}, \qquad (1)$$

where:

E – total water use, m^3/ha;

M – irrigation rate, m^3/ha;

O – precipitation, m^3/ha;

W_h – moisture content in the active soil layer at the beginning of the growing season, m^3/ha;

W_k – moisture content in the active soil layer at the end of the growing season, m^3/ha.

The coefficient of water use of the crops in the crop rotation on the irrigated lands was determined by the formula (2) [19]:

$$\mathbf{K_E = E/Y}, \qquad (2)$$

where:
K_E – coefficient of water use, m^3/t;
E – total water use for the growing season, m^3/ha;
Y – yield of the crop, t/ha.

RESULTS AND DISCUSSIONS

The best conditions for growth and development of the plants are formed under the optimal structure of the active soil layer. Numerous studies have proved the necessity for finding out such parameters of loosening or bulk density of the soil, which would be most corresponding to the biological requirements of agricultural plants. It is established that for the soil, which have steady-state density equal to the optimal for a certain crop, there is no need in deep tillage.

Most crops require bulk density of 1.1-1.3 g/cm^3. The share of corn and soybeans in the irrigated crop rotations is 25-50%. These crops require loose, rich in nutrients and water arable and root layer of the soil to grow intensively. The optimal bulk density of the soil for corn, soybeans and sorghum crops is 1.1-1.2 g/cm^3, and 1.1-1.4 g/cm^3 for winter wheat. If this index exceeds the figure of 1.27 g/cm^3 at the time of sprouting in row crops, this has an adverse effect on further growth and development of the plants. The studies of the Institute of Irrigated Agriculture of NAAS established that these conditions are better satisfied on the dark-chestnut soils of the South of Ukraine under moldboard basic tillage when organic fertilizers like by-products (stems and straw of corn, soybeans, and sorghum) and immobile phosphorus fertilizers are incorporated to the depth of 14-16 to 25-27 cm or in the zone of stable humidification and the maximum spreading of the root system. In the variants of plowless basic tillage the bulk density of 0-40 cm soil layer was 1.34-1.36, and in the variants of multi-depth plowing and differentiated systems this figure was 1.33-1.35 g/cm^3. Such a level of bulk density favored to growth and development of winter wheat, while under plowless tillage these figures were lower than biologically optimal for corn, sorghum, and soybeans by 4.6 % (Table 1).

Table 1. Bulk density of 0-40 cm layer of the dark-chestnut soil depending on basic tillage in the crop rotation, beginning of the growing season, g/cm^3

System of basic tillage	Crop				Average by the crop rotation
	Grain corn	Soybeans	Grain sorghum	Winter wheat	
Moldboard multi-depth	1.35	1.32	1.33	1.33	1.33
Plowless multi-depth	1.35	1.34	1.34	1.35	1.34
Shallow single-depth plowless	1.36	1.36	1.35	1.36	1.36
Differentiated-1	1.34	1.33	1.33	1.34	1.33
Differentiated-2	1.34	1.34	1.35	1.35	1.34
LSD_{05}	0.07	0.05	0.08	0.06	

Source: Own study.

Dynamics of the bulk density by the soil layers with deepening from 0-10 to 30-40 cm is important in the initial stages of the plants' growth and development.

The highest loosening of the soil layer 0-20 cm was in the variant of plowing on the depth from 14-16 to 25-27 cm in the system of multi-depth moldboard tillage, and usage of plowless shallow single-depth tillage resulted in compaction of the layers 0-10 and 10-20 cm by 4.0-8.8% in comparison to the control.

Precipitation of the autumn-winter period and seasonal irrigation significantly compacted the soil. The regularity, which was established in the initial time of growing season, remained – plowless tillage resulted in greater bulk density in comparison to biologically optimal for corn, sorghum, and soybeans by 6.9-7.7% (Table 2).

During this period, the compaction of the lower layers of the soil (20-40 cm) is more significant in comparison with the layer of 0-20 cm, both by the variants of the experiment and under the crops. The maximum values of the bulk density in the soil layer of 30-40 cm, on average by the crop rotation, corresponded to the variant of shallow tillage on 12-14 cm in the system of single depth plowless basic tillage and the figures were 1.40-1.45 g/cm^3. At the same time, because the optimal bulk density for cereals is within 1.1-1.4 g/cm^3, it is advisable to replace deep moldboard and plowless loosening with shallow and surface basic tillage. On the dark-chestnut middle loamy soils, the density of which in the steady-state reaches 1.41-1.42 g/cm^3 for row crops – corn, sorghum, and soybeans, the best results are provided by deep moldboard or plowless tillage.

Table 2. Bulk density of 0-40 cm layer of the dark-chestnut soil depending on basic tillage in the crop rotation, end of the growing season, g/cm^3

System of basic tillage	Crop				Average by the crop rotation
	Grain corn	Soybeans	Grain sorghum	Winter wheat	
Moldboard multi-depth	1.36	1.36	1.38	1.36	1.36
Plowless multi-depth	1.37	1.39	1.39	1.36	1.38
Shallow single-depth plowless	1.39	1.40	1.42	1.38	1.40
Differentiated-1	1.36	1.38	1.39	1.38	1.38
Differentiated-2	1.36	1.39	1.41	1.39	1.39
LSD_{05}	0.06	0.06	0.09	0.07	

Source: Own study.

Thus, determined at the beginning of the growing season of the plants porosity of the soil layer of 0-40 cm, on average by the crop rotation, was in the range of 48.0-48.9%, which corresponded to the variants of plowing to the depth of 14-16 to 25-27 cm in the system of multi-depth moldboard basic tillage in the crop rotation (variant 1) and differentiated system (variant 4), while long-term use of shallow (12-14 cm) tillage in the system of single-depth plowless loosening in the crop rotation (variant 3) reduced the porosity by 1.6 %. Before harvesting, the soil was compacted, and the porosity decreased to 46.0-47.4%, or by 2.9-4.2%.

Increased bulk density, and, accordingly, lower porosity in plowless tillage methods, especially under prolonged use of shallow loosening in the crop rotation (variant 3), led to a decrease in water permeability at the beginning of the growing season by 12.0-21.2%, and to the time of harvesting by 20.7-26.3%.

The maximum values of water absorption and filtration rate corresponded to the system of multi-depth moldboard basic tillage (variant 1) and the variant of differentiated-1 tillage with one para-plowing to the depth of 38-40 cm (variant 4) in the crop rotation.

Based on the results of experimental studies, it is established that under the influence of different methods and depth of basic tillage conducted on the dark-chestnut middle loamy soil in the crop rotation, agrophysical properties are formed, which create favorable conditions for accumulation and retention of moisture in the root layer providing optimal conditions for growth and development of the plants and further yield formation.

Determination of moisture reserves in the soil layer of 0-100 cm at the beginning of the renewal of vegetation of winter wheat and sprouting of spring crops (soybeans, grain corn, and sorghum), indicates that the methods and depth of tillage in the crop rotation had an impact on the accumulation and formation of moisture reserves in the soil profile. Higher reserves of productive and total moisture were formed in the variant with differentiated-1 tillage because para-plowing contributed to better absorption of precipitation in the autumn-winter period, and under single-depth shallow disk tillage (12-14 cm) they were minimal. Analysis of moisture reserves and water use during the growing season testifies about the in-time irrigation, which, together with precipitation, provided optimal water conditions for the crops in the rotation.

The total water use of the crops per 1 ha of the crop rotation area ranged within 5,093-5,294 m^3/ha depending their biological features, the length of the growing season and tillage methods.

Analyzing the amount of moisture used depending on the systems of the basic tillage, it should be mentioned that for multi-depth plowing and differentiated-1 tillage, 1,040 and 1,075 m^3/ha were used, respectively, per 1 ha of the crop rotation area, and for plowless multi-depth, shallow single-depth, and differentiated-2 systems the volumes ranged within 839-964 m^3/ha, or less compared to the control by 19.3-7.3%. In accordance with the use of soil moisture, the level of total water use was formed at the level of 5,294, 5,218 and 5,329 m^3/ha. Under the system of differentiated-2 tillage with one plowing per the crop rotation, this index decreased to 5,192 m^3/ha, and the use of shallow tillage (variant 3) reduced its value to 5,093 m^3/ha. Analysis of the components of total water use testifies that the need for water by the tillage variants is provided by 18-22% at the expense of productive moisture reserves in the soil, 23-24% by precipitation and 55-58% at the expense of irrigation water (Table 3).

Our results on the effect of tillage methods and depths on the soil water regime are supported by another study, conducted on the dark-chestnut soil with chickpea [9]. It was determined that the highest chickpea yields were provided by moldboard tillage on 28-30 cm, together with the highest desalination of the soil due to the crop cultivation.

Table 3. Water regime of the soil at different systems of basic tillage in the crop rotation under irrigation

Indices	Tillage system				
	Moldboard	Plowless-1	Plowless-2	Differentiated-1	Differentiated-2
Water use, m^3/ha	5,294	5,218	5,093	5,329	5,192
Water balance elements:					
Soil moisture, m^3/ha; %	1,040 20	964 18	839 16	1,075 20	938 18
Precipitation, m^3/ha; %	1,254 24	1,254 24	1,254 25	1,254 24	1,254 24
Irrigation rate, m^3/ha; %	3,000 56	3,000 57	3,000 59	3,000 56	3,000 58
Coefficient of water use, m^3/t	1,134	1,222	1,664	1,064	1,242
Mean daily evaporation, m^3/ha	46.4	45.8	44.6	46.8	45.5

Source: Own study.

The highest efficiency of water use per ton of the product was in the variant with the systems of moldboard multi-depth (1,134 m^3/t) and differentiated-1 tillage (1,064 m^3/t), while plowless shallow tillage (12-14cm) increased the water use up to 1,644 m^3/t or by 33.2%.

Analyzing the values of mean daily evaporation, it is necessary to point out that it increased by 4.9%, from 44.6 m^3/ha under shallow plowless single-depth tillage to 46.8 m^3/ha under differentiated tillage.

The most favorable conditions for the formation of crop yields were created on the organic background with the differentiated system of basic tillage with one deep loosening to the depth of 38-40 cm once per the crop rotation with a rate of 3.71 t/ha of grain units, which exceeds the control by 2.2%.

The organo-mineral background with the application of $N_{82.5}P_{60}$ + by-products resulted in the crop rotation productivity increase, compared to the organic system in the variant with multi-depth plowing and differentiated-1 tillage, by 86.5%, and under plowless and differentiated -2 by 90-103%.

Increasing the dose of mineral fertilizer to $N_{120}P_{60}$ contributed to an increase in the crop rotation productivity compared to the dose of $N_{82.5}P_{60}$ by 19.3-26.0%.

Replacement of moldboard and plowless multi-depth tillage and differentiated by methods and depth with systematic shallow loosening (variant 3) led to a decrease in the productivity to 5.23 grain units in the fertilization system No. 1 and to 6.48 grain units in the fertilization system No. 2 (Table 4).

Table 4. Productivity of the crop rotation at different fertilization systems and systems of basic tillage, average for 2016-2020

System of basic tillage	Fertilization system	Productivity (t/ha)				
		Corn	Sorghum	Soybeans	Winter wheat	Grain Units (t/ha)
Moldboard multi-depth	organic	4.38	2.83	2.69	3.14	3.63
	$N_{82.5}P_{60}$ +by-products	11.60	6.79	3.55	5.84	6.77
	$N_{120}P_{60}$ +by-products	14.77	6.97	4.22	6.82	8.44
Plowless multi-depth	organic	3.92	2.47	2.41	3.03	3.23
	$N_{82,5}P_{60}$ +by-products	10.94	6.52	3.26	5.67	6.39
	$N_{120}P_{60}$ +by-products	14.04	6.73	3.90	6.46	8.05
Plowless shallow single-depth	organic	3.07	2.04	1.84	2.76	2.75
	$N_{82.5}P_{60}$ +by-products	8.27	4.59	2.47	5.34	5.23
	$N_{120}P_{60}$ +by-products	10.09	4.76	2.91	6.21	6.48
Differentiated-1	organic	4.61	3.12	2.68	3.22	3.71
	$N_{82.5}P_{60}$ +by-products	11.94	7.72	3.62	6.04	6.92
	$N_{120}P_{60}$ +by-products	15.11	7.94	4.12	6.93	8.50
Differentiated-2	organic	4.01	2.44	2.30	2.86	3.20
	$N_{82.5}P_{60}$ +by-products	10.89	6.18	3.22	5.52	6.51
	$N_{120}P_{60}$ +by-products	13.67	6.33	3.71	6.39	7.77

Source: Own study.

The highest level of gross output was obtained with a differentiated system of basic tillage with one para-plowing to the depth of 38-40 cm once per the crop rotation on the background of application of $N_{120}P_{60}$, where its cost was 38.9 thousand UAH (Table 5).

Similar results were obtained in the control with a rate of 38.6 thousand UAH, and cultivation technologies based on the plowless multi-depth tillage led to a decrease in gross output by 4.4%, while single-depth shallow tillage declined the production by 21.8 % and differentiated-2 system of tillage cut the gross output by 10.9%.

A similar pattern was observed on the non-fertilized background and on the generally accepted dose of mineral fertilizers.

Previously, it was also proved that the economic efficiency of crop production is greatly dependent on the fertilization system [18].

The expenditures for the crops cultivation by to the variants of the experiment differed mainly in the operation costs for basic tillage, transportation and processing of the yield.

The highest net profit of 20.4 thousand UAH with a profitability level of 110.1% was obtained under the application of mineral fertilizers in the dose of $N_{120}P_{60}$ and the use of differentiated -1 system of basic tillage with para-plowing to the depth of 38-40 cm once per the crop rotation, while under the systems of multi-depth moldboard basic tillage the profit was lower by 4.1%.

Table 5. Productivity and economic efficiency of the crop rotation under different systems of basic tillage and fertilization

System of basic tillage	Fertilization system	Grain Units, t/ha	Gross Product Cost, UAH	Expenditures, UAH	Profit, UAH/ha	Profitability, %	Fertilizers Output kg/kg of GU
Moldboard multi-depth	No	3.63	16.9	12.1	4.8	38.9	-
	$N_{82.5}P_{60}$	6.77	30.8	17.4	13.4	76.8	23.3
	$N_{120}P_{60}$	8.44	38.6	19.0	19.6	102.6	26.7
Plowless multi-depth	No	3.23	15.1	11.6	3.26	30.1	-
	$N_{82.5}P_{60}$	6.39	29.1	17.0	12.1	71.2	23.4
	$N_{120}P_{60}$	8.05	36.8	18.6	18.2	97.6	26.8
Plowless shallow single-depth	No	2.75	12.9	11.4	1.5	12.8	-
	$N_{82.5}P_{60}$	5.23	24.1	16.7	7.4	44.7	18.4
	$N_{120}P_{60}$	6.48	30.2	18.3	11.9	64.9	20.7
Differentiated-1	No	3.71	17.2	11.6	5.6	48.4	-
	$N_{82.5}P_{60}$	6.92	31.5	16.9	14.6	86.2	23.8
	$N_{120}P_{60}$	8.50	38.9	18.5	20.4	110.1	26.6
Differentiated-2	No	3.20	14.8	11.5	3.3	28.7	-
	$N_{82.5}P_{60}$	6.51	29.5	16.8	12.7	75.4	24.5
	$N_{120}P_{60}$	7.77	34.4	18.4	16.0	86.9	25.4

Source: Own study.

CONCLUSIONS

The most favorable agrophysical properties and water regime of the dark-chestnut soil in the South of Ukraine for the cultivation of row crops is created under differentiated-1 system of basic tillage with application of $N_{120}P_{60}$ + by-products per the hectare of the crop rotation area. The mentioned cultivation technology guarantees obtaining the best profitability level of 110.1% in comparison to 38.9% on the control.

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ECONOMIC-FINANCIAL ASPECTS OF THE ACTIVITY AT SC POTELU AGRICOM L.L.C., POTELU VILLAGE, OLT COUNTY, ROMANIA (2017-2019)

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Abstract

The aim of the paper was to analyze the economic and financial aspects of the commercial company AGRICOM L.L.C. in the period 2017-2019 using the specific indicators. The unit has a considerable age (the company's statute was updated in 2012), being included in the field of activity "cultivation of non-perennial plants", and as main object of activity cultivation of cereals (excluding rice), legumes and seed plants oilseeds " – CAEN code 0111. The unit works an area of 49.07 ha, and in addition makes distribution and sale of inputs related to the production process in agriculture (fertilizers, seeds, control substances). The unit has, according to the Balance of fixed assets, endowments worth 493,877.86 lei. The unit grew winter wheat, corn, peas, sunflower, rapeseed and alfalfa. Through the culture palette practiced, it aimed to ensure the conditions related to the subsidy of the activity. The unit registers operating profit - 146,654.33 lei and pays a tax of 7,821 lei, aspects that lead to a net profit of 138,833.33 lei (average values for the period 2017, 2018 and 2019).

Key words*: *expenses, turnover, profit, area, income

INTRODUCTION

The unit is located in Potelu village, Ianca commune, Olt County. The village of Potelu is documented on September 1, 1491 - August 31, 1492, by a deed issued by Vlad Călugărul [3]. The village is located in the South-Eastern part of Ianca Commune, with the following coordinates: 43076´67´´ North latitude and 24020´13´´ degrees East longitude [10]. The location in the territory highlights distances 25 km from Corabia, 56 km from Caracal, 88 km from Craiova and 96 km from Slatina [2]. This situation can determine some negative aspects related to the possibilities, concrete, of supply and sale of the company.

The unit has a considerable age (in 2012 the company's statute was updated), having as main field of activity "cultivation of non-perennial plants", and as main activity "cultivation of non-perennial plants - cultivation of cereals (excluding rice), legumes and producing plants of oilseeds "- CAEN Code 0111.

The incorporation of the company was based on the existence of a single shareholder, a Romanian citizen, who constituted a legal entity in the form of a limited liability company (SRL).

The declared headquarters of the company is located in Ianca Commune, Potelu village, 111 Valea Dunării Street, Room 3, Olt County, it can set up branches, according to the legislation in force.

In addition to the main activity, the company may also carry out as a secondary object of activity: the cultivation of various plant species (rice, tobacco, fiber-producing plants, vegetables, etc.); manufacture of various goods; wholesale and retail trade (various agricultural products); service activities ancillary to agriculture; business consulting and management activities; storage; manipulations etc.

The duration of the company's existence is unlimited, the subscribed share capital was 200 lei (20 shares), the increase and reduction of the capital, as well as its transfer can be done under concrete conditions stipulated in the founding act.

The articles of association also contain provisions regarding: the rights, obligations and attributions of the associates; how to organize;

issues related to the administration, activity and control of the company; matters relating to the dissolution, liquidation, merger and division of the company, the company's personnel, the preparation of the Balance Sheet and the Profit and Loss Account, the calculation and distribution of profit, litigation and final provisions [7].

In addition to the productive activity, the company is involved in the segment of providing inputs for agriculture (fertilizers, herbicides, pesticides, fungicides, etc.), where it carries out a rather complex activity.

The material base of the company comprises a series of mechanical and surveillance equipment (categories: fixed assets 2: tractors - 2 pieces, plow with 4 bodies, vibratory cultivator, scarifier, fertilizer spreader, seed drills - 2 pieces, herbicide plant - 2 pieces; fixed assets 3: alarm system). It should be noted that these facilities are relatively new (purchased between 2014 - 600 l herbicide plant and the seed drill in frequent rows and 2019 - the scarifier, respectively), have variable input values (from 3,491.34 lei - surveillance system up to 167,950.10 lei - tractor DF 5105) and are depreciated in different proportions (from 5% - scarifier to 95% - herbicide plant) [9].

MATERIALS AND METHODS

For this paper, the following indicators were determined and interpreted according to the recommended methodology: cultivated area (ha) and its structure (%); financial indicators - income (net turnover, other operating income, operating income - total expressed in lei); of expenses (expenses with raw materials and materials, personnel expenses, adjustments regarding tangible and intangible assets, other operating expenses, total operating expenses expressed in lei); profitability indicators: operating profit or loss (lei), profit tax (lei), net profit or loss (lei), operating profit or loss rate (%), net profit or loss rate (%).

The category of other operating expenses includes: external benefits, other taxes - fees - payments, compensation for donations, assigned assets.

For agricultural producers, income is the main result of the core business [12]. Revenue is influenced by the quantity of products sold and the market price [6]. Minimizing costs can lead to higher profits [5]. From this perspective, the competitiveness of spending is a sensitive issue for agricultural producers [1]. Profit depends on income and expenses. Profit is the indicator that expresses the efficiency of activity in agricultural units [4]. Gross profit of a producer also includes profit tax, which is made available to the state [11].

It should be noted that the unit did not have any financial income and expenses, which means that the operating income and expenses are the same as the total income and expenses. This situation determines the similarity between the operating profit or loss and the gross profit or loss. Regarding the calculation of the profit tax, the unit benefited from certain facilities - for the analysed period.

For the comparison over time, of the indicators, fixed and mobile base indices were used.

RESULTS AND DISCUSSIONS

The unit practiced 6 crops (autumn wheat, corn, peas, sunflower, rapeseed and alfalfa). From the beginning, the stability of the total area (49.70 ha) for the analysed period should be noted (Table 1).

The wheat crop had areas between 6.12 and 29.45 ha (2017 and 2019, respectively), and the average of the period reached 17.37 ha (+183.32 and -41.02% compared to the reporting terms). The dynamics of the indicator is strictly increasing, the successive annual growth being: 2.70 times in 2018 (16.56 ha) and 1.77 times respectively in the case of 2018.

The grain maize crop registered an average of 4.35 ha (subunit value compared to the first reference base and supra-unit value compared to the second comparison term), given that the annual sequential areas were: 9.85 ha in 2017, 1.47 ha at the level of 2018 (-85.08%) and 1.73 ha respectively for 2019 (-82.44 and + 17.69% in dynamics).

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Table 1. Cultivated area

Specification	Year									Period average**			
	2017			2018			2019						
	Ef. (ha)*	Dynamic**		Ef. (ha)*	Dynamic**		Ef. (ha)*	Dynamic**		Ef. (ha)	Dynamic		Str. (%)
		Ibf	Ibm		Ibf	Ibm		Ibf	Ibm		Ibf	Ibm	
Wheat	6.12	100	100	16.56	270.59	270.59	29.45	4.81 times	177.84	17.37	283.82	58.98	34.96
Corn grain	9.85	100	100	1.47	14.92	14.92	1.73	17.56	117.69	4.35	44.16	251.44	8.75
Green peas	17.05	100	100	5.00	29.33	29.33	15.86	93.02	3.17 times	12.64	74.13	79.70	25.43
Sunflower	15.86	100	100	21.85	137.77	137.77	2.66	16.77	12.17	13.46	84.87	5.06 times	27.08
Rapeseed	-	-	-	4.00	100	100	-	-	-	1.33	33.33	-	2.67
Alfalfa	0.82	100	100	0.82	100	100	-	-	-	0.55	67.07	-	1.11
Total cultivated	49.70	100	100	49.70	100	100	49.70	100	100	49.70	100	100	100

Source: *S.C. Potelu Agricom LLC - Primary evidence data;
**own calculations.

The pea was cultivated on areas between 5.0 and 17.05 ha in the years 2018 and 2016, respectively, and the average of the period reached 12.64 ha. The dynamics of the indicator was uneven, so that there are decreases of 70.67% in 2018 compared to the first level of dynamic series, increases in 2019 (3.17 times compared to the previous year), while the average for the period is below both reference terms (2017 and 2019) by 25.87 and 20.30% respectively.

At sunflower there was an average area of 13.46 ha (-15.13% compared to 2017 and an advance of 5.06 times the specific level of 2019), with limits of 2.66 ha in 2019 (-83.23 and -87.83% compared to the terms reporting) and 21.85 ha in the case of 2018. The indicator has evolved fluctuating: increases in 2018 compared to 2017 (+37.77%), spectacular declines in 2018.

Rapeseed was cultivated on only 4 ha in 2018 so that the average of the period reached 1.33 ha.

Alfalfa was cultivated only in 2017 and 2018 on the same area accounting for 0.82 ha. The dynamics was uniformly descending (level of equity in 2018 and 67.07% for the fixed basis indices for the average of the period).

For the average of the period, the following structure of the cultivated area is found (Fig. 1): 1.11% alfalfa (0.55 ha); 2.67% rapeseed (1.33 ha); 8.75% corn grain (4.35 ha); 25.43% peas (12.64 ha); 27.08% sunflower (13.46 ha); 34.96% wheat (17.37 ha).

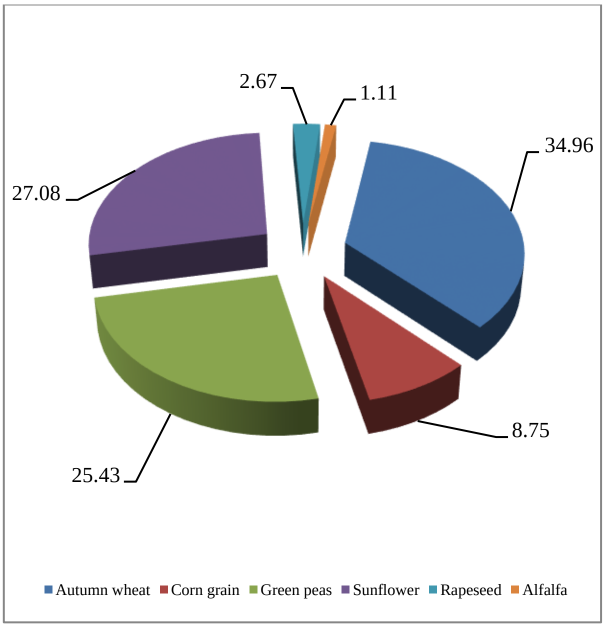

Fig. 1. The structure of the cultivated arable land - the average of the period (%)
Source: Own design and calculation.

Table 2 shows the financial indicators, according to the Profit and Loss Account [8].

The net turnover, which varied from 606,890 lei in 2017, to 973,718 lei in 2019, to which adding the specific value of 2018 (707,636 lei) reached an average of the period of 762,748 lei (Fig. 2).

The indicator has evolved upwards: increases by 16.60% in 2018 compared to the specific situation in 2017, ahead of 1.60 and 1.37 times in 2018 compared to the reporting terms, increase by 25.68% of the average compared to 2019.

For other incomes, there is an average of 130,153.33 lei (-2.14 and -31.99% in dynamics), which is based on annual sequential levels of: 133,004 lei in 2017, 66,310 lei in 2018 (-50.14% compared to the comparison basis), 19,146 lei in 2019 (1.20 times ahead of the first reference term and a decrease of 23.35% compared to the second reporting term (Fig. 2).

Table 2. Financial indicators

Specification	Year									Period average**		
	2017			2018			2019					
	Ef. (lei, %)*	Dynamic**		Ef. (lei, %)*	Dynamic**		Ef. (lei, %)*	Dynamic**		Ef. (lei, %)	Dynamic	
		Ibf	Ibm		Ibf	Ibm		Ibf	Ibm		Ibf	Ibm
Net turnover	606,890	100	100	707,636	116.60	116.60	973,718	160.44	137.60	762,748.00	125.68	78.33
Other incomes	133,004	100	100	66,310	49.86	49.86	191,146	143.71	288.26	130,153.33	97.86	68.09
Operating income	739,894	100	100	773,946	104.60	104.60	1,164,864	157.44	150.51	892,901.33	120.68	76.65
Expenditure on raw materials and consumables	152,278	100	100	160,888	105.65	105.65	134,184	88.12	83.40	149,116.67	97.92	111.13
Staff expenditure	19,228	100	100	23,454	121.98	121.98	32,308	168.03	137.75	24,996.66	130.01	77.37
Adjustments for property, plant and equipment and intangible assets	69,625	100	100	79,841	114.67	114.67	74,676	107.25	93.53	74,714.00	107.31	100.05
Other operating expenses	474,734	100	100	397,722	83.78	83.78	619,803	130.56	155.84	497,419.67	104.78	80.25
Total operating expenses	715,865	100	100	661,905	92.46	92.46	860,971	120.27	130.07	746,247.00	104.24	86.68
Operating profit or loss ***	24,029	100	100	112,041	4.66 times	4.66 times	303,893	12.65 times	271.23	146,654.33	6.10 times	48.26
Tax	6,069	100	100	7076	116,59	116.59	10,318	170.01	145.82	7,821.00	128.87	75.80
Net profit or loss	17,960	100	100	104,965	5.84 times	5.84 times	293,575	16.35 times	279.69	138,833.33	7.73 times	47.29
Operating profit rate	3.35	100	100	16.93	5.05 times	5.05 times	35.30	10.54 times	208.51	19.65	5.87 times	55.67
Net profit rate	2.51	100	100	15.86	6.32 times	6.32 times	34.10	13.59 times	215.01	18.60	7.41 times	54.55

Source: * Data extracted from the Profit and Loss Account (2017 – 2019) [8].
** Own calculations;
*** Identical to gross profit or loss;

Operating revenues ranged from 739,894 to 1,164,864 lei (2017 and 2019, respectively), and the average for the period reached 892,901.33 lei (Fig. 2).

The dynamics of the indicator is strictly ascending, predominating the supra-unitary levels of the component indices - except for those with a mobile base in the case of the average period (76.65%). Advances of the reference bases reached: 1.04 times in 2018, 1.57 and 1.50 times in 2019, 1.20 times for the average of the period.

In the structure of revenues, the net turnover predominates with 85.42%, other revenues representing 14.58%.

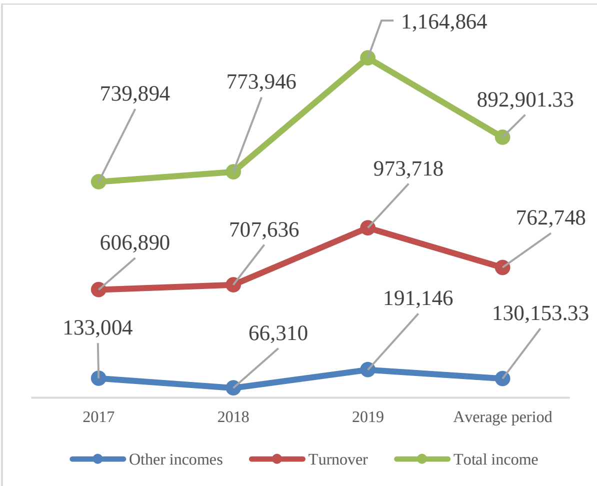

Fig. 2. Income indicators (lei)
Source: Own design and calculation based on [8].

Expenditures on raw materials and consumables are characterized by an average of 149,116.67 lei (-2.08 and +11.13% compared to the terms of reference), given that the annual sequential levels were: 152,278 lei in 2017, 160,888 lei for year 2018 (+5.65% in dynamics), 134,184 lei in the case of 2019 (-11.88 and -16.60% compared to the reporting bases). We can say that the dynamics of the indicator is uneven (Fig. 3).

Personnel expenses ranged from 19,228 lei in 2017, to 32,308 lei in 2019, and the average for the period was 24,996.66 lei (Fig. 3). The indicator has evolved upwards, over time, registering successive annual increases with 21.98 and 37.75% in the case of 2018 and 2019, respectively.

The adjustments regarding the tangible and intangible fixed assets had an average of 74,714 lei, which represented a superior positioning compared to the terms of reference (107.31 and 100.05%). This average is based on the following annual situations: 69,625 lei in 2017, 79,841 lei in 2018 (1.14 times ahead of the reference term), 74,676 lei in 2018 (1.07 times ahead of the first basis of comparison and a decrease of 6.47 % compared to the second reporting base (Fig. 3).

Regarding the situation for other operating expenses, there are extreme levels of 397,722 lei in 2018 and 619,803 lei for 2019, respectively, and the average for the period reached 497,419.67 lei (Fig. 3). The dynamics of the indicator is uneven: decreases by 16.22% in 2018, increases by 55.84% in 2019 compared to the previous term, decreases by 19.75% of the average of the period compared to the specific situation of 2019.

The total operating expenses had an average of 746,247 lei, as a result of the annual sequential levels of: 715,865 lei in 2017, 661,905 lei in 2018, 860,971 lei in 2019 (Fig. 3). It can be seen that the indicator has evolved fluctuating (-7.54% in 2018, +20.27 and +30.07% for 2019, +4.24 and -13.32% at the average of the period).

The structure of total expenses is dominated by other operating expenses - 66.66%, followed by expenses with raw materials and consumables - 19.98%, adjustments on tangible and intangible assets - 10.01%, personnel expenses - 3.35% (Fig. 4).

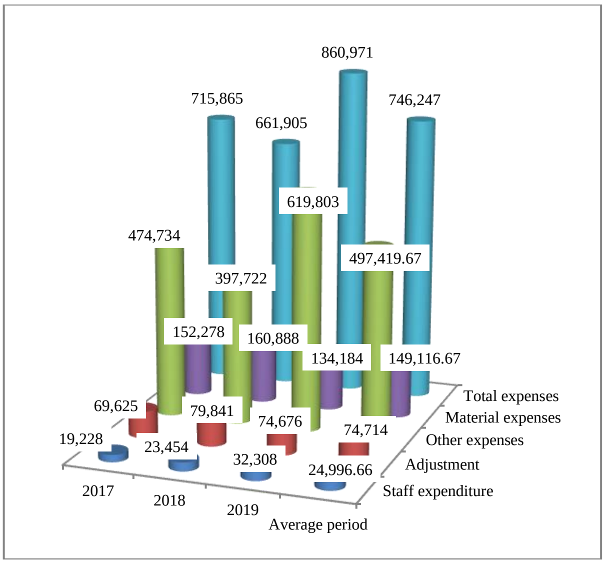

Fig. 3. Expenditure indicators (lei)
Source: Own design and calculation based on [8].

The operating profit varied from 24,029 lei in 2017, to 303,893 lei in 2019, and the average for the period was 146,654.33 lei (Fig. 5). There is an upward evolution of the indicator: spectacular overtaking in 2018 compared to 2017 (4.66 times), sharp overtaking in 2019 compared to the previous term of the dynamic series (2.71 times), 6.10 times increase of the average period compared to the state of things specific to 2017 and a decrease of 51.74% compared to 2019.

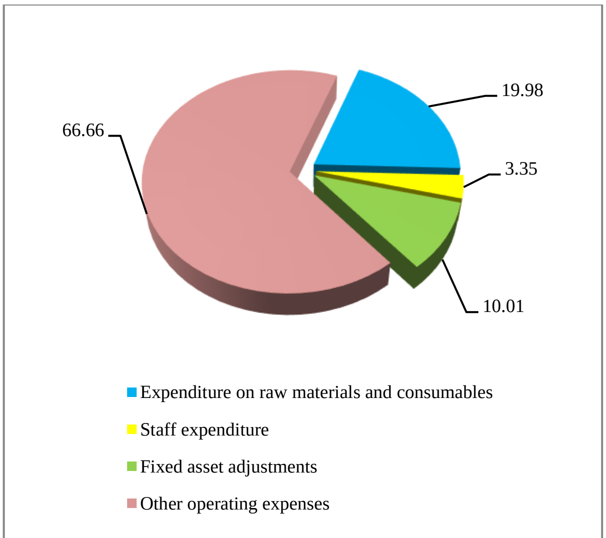

Fig. 4. Structure of total expenditures - average of the period (%)
Source: Own design and calculation based on [8].

The profit tax registered an average of 7.821 lei (+28.87 and -24.20% in dynamics - Fig. 5), given that the annual levels of the indicator were 6.069 lei in 2017, 7.076 lei in 2018 (1.16 times ahead of the comparison deadline), 10.318 lei for 2019 (exceeding by 70.01 and 45.82% the reporting bases). The net profit is characterized by extreme values of 17,960 and 293,575 lei in 2017 and 2019, respectively, and the average for the period reached 138,833.33 lei (Fig. 5). The dynamics of the indicator is an ascending one, the advances of the reporting term being 5.84 times in 2018, 16.35 and 2.79 times respectively for 2019, and the average of the period is 7.73 times ahead of the first comparison term (-52.71% compared to 2019). The operating profit rate was 3.35% in 2017, 16.93% for 2018, 35.30% in 2019 and 19.65% for the average of the period (Fig. 6). The evolution of the indicator was marked by an upward trend, only chain basis indices being below the average of the period (55.67%). The net profit rate is the last indicator of profitability (Fig. 6). It can be shown that it registered an average of 18.60% (7.41 times ahead of the first reporting base and a decrease of 45.45% compared to the second), with extreme values of 2.51% for 2017 and 34.10% in 2019. As a result of this situation, the dynamics is increasing: there is an advance of 6.32 times in 2018 compared to the first term of the dynamic series, advances of the reporting bases of 13.59 and 2.15 times, in the case of 2019.

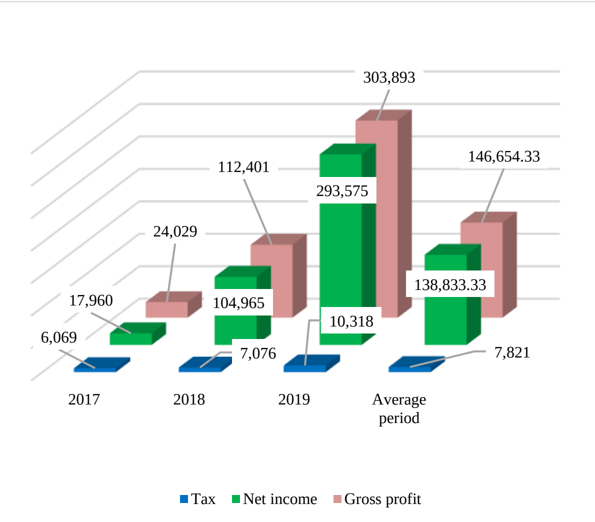

Fig. 5. Operating profit and net profit (lei)
Source: Own design and calculation based on [8].

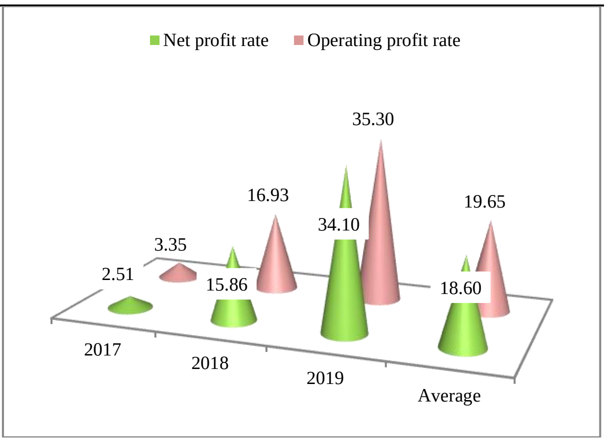

Fig. 6. Operating profit rate and net profit rate (%)
Source: Own design and calculation based on [8].

CONCLUSIONS

The unit is a traditional one - in the area, as such, the entrepreneur already has a certain market segment and further aims to strengthen its position in the socio-economic environment of existence.

The unit exploits a relatively small area of land (49.70 ha), observing variations of the range of crops practiced based on existing market demand, but there is also a stability in terms of production capacity and the application of appropriate technological and economic measures. (rotation, personnel policy, "green crops", etc.).

The unit registered an operating profit - 146,654.33 lei and paid a tax of 7,821 lei, situations that determine the obtaining of a net profit of 138,833.33 lei.

Finally, it can be appreciated that there is a need for adequate management of expenditure items, but the initiative of the entrepreneur to reinvest part of the profit for the development of the unit (aspect based on data from the Register of fixed assets - new equipment and machinery, most old is 7 years old since purchase) [9].

The unit will focus on the proper conduct and activity of distribution and sale of inputs.

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ANTIOXIDANT ACTIYITY OF LEAF AND FRUIT EXTRACTS FROM *RUBUS FRUTICOSUS*, *RUBUS IDAEUS* AND *RUBUS LOGANOBACCUS* GROWING IN THE CONDITIONS OF THE REPUBLIC OF MOLDOVA

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Abstract

The identification of alternative crops that require less water and produce high yields of organic matter is an important step towards a sustainable agriculture. This research was focused on determining the level of antioxidant activity of leaf and fruit extracts of some Rubus species, growing under the climatic conditions of the Republic of Moldova: Rubus fruticosus L., Rubus idaeus L. and Rubus loganobaccus L.H. Bailey. We evaluated the total phenol content (Folin-Ciocalteau assay): in vitro antioxidant capacity employing DPPH; ABTS methods and ferrozine test for iron chelating capacity. In leaf extracts, the total phenolic content ranged from 28.70 to 90.84 GAE/g DW and in fruit extracts – 13.97 to 45.08 GAE/g DW. In all assays, the leaf extracts of studied Rubus species showed the highest values of antioxidant activity (DPPH — IC_{50}) = 45.39 — 68.11 µg/ml; ABTS — 42.57 µM TE/g dry matter, iron chelating capacity — 53.06 %). A high correlation was found between the values for the total phenolic content and the antioxidant activity. Our results confirmed that leaf extracts of Rubus species can prevent activity of free radicals by scavenging or by inhibiting them.

Key words: *antioxidant activity, fruit and leaf extracts, Rubus fruticosus, Rubus idaeus, Rubus loganobaccus, total phenols*

INTRODUCTION

In recent years, a lot of attention has been paid to improving the live quality and reducing the use of synthetic ingredients in food and strengthening health, which is why there has been an increase in the interest in fruits, which are rich in natural compounds, and are indispensable for a healthy diet, promoted by the World Health Organization (WHO). Healthy eating involves the daily consumption of fruits rich in antioxidants, of a phenolic nature and last but not least, those rich in various vitamins.

There has always been a permanent concern for horticulturists to mobilize and expand the fruit assortment to meet the demands of consumers for fresh fruits throughout the year, but also – of the food and pharmaceutical industry, regarding the creation of a diversified assortment of food and raw materials for obtaining various biologically active compounds for maintaining and strengthening human health [1, 2, 4, 7, 9].

The notions of free radicals or reactive oxygen species (ROS) are used to describe chemical compounds that contain one or more unpaired electrons, because of which, they are highly unstable and are capable of causing damage to other molecules by taking electrons from them in order to stabilize themselves. Free radicals are created during normal metabolic processes in the cells and play a dual role in the body, with both harmful and beneficial effects. Excess production of reactive oxygen species (ROS) and/or a decrease in antioxidant levels may lead to the tissue damage and different diseases. Oxidative stress has been linked to many human diseases, as either a cause or an effect. Antioxidants are substances that can prevent the damage caused by free radicals and it is considered that a sufficient intake of antioxidants can protect against many diseases. The human body produces several antioxidant enzymes, such as superoxide dismutase, catalase and glutathione peroxidase, which are able to neutralize many

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types of free radicals. Antioxidants can act as free radical scavengers, by inhibiting their formation (e.g. by blocking activation of phagocytes) and preventing formation of OH and/or decomposition of lipid hydroperoxides, by repairing the caused damage or by any combination of the above. Recent studies suggest that the antioxidants derived from plant materials, such as vegetables, fruits etc., with free-radical scavenging properties, may have great therapeutic effects in diseases associated with oxidative stress, such as cancer, diabetes, neurodegenerative disease, cardiovascular diseases, arthritis and gastrointestinal diseases and may slow down the aging process. Many synthetic antioxidants have shown toxic and/or mutagenic effects, while plant-based remedies have usually fewer side effects than the synthetic drugs [4, 7, 11, 12, 22].

The genus *Rubus*, family *Rosaceae*, includes about 1500 species, 10 species of *Rubus* are found in the spontaneous flora of the Republic of Moldova: (*R. caesius* L., *R. canescens* DC., *R. constrictus* Lef. et P.J. Mull., *R. hirtus* Waldst. et Kit., *R. idaeus* L., *R. montanus* Libert ex Lej., *R. nessensis* Hall., *R. serpens* Weihe ex Lej. et. Court. *R. tereticaulis* P.J.Mull., *R. ulmifolius* Schott.)[21].

Species, cultivars, mutant forms and new hybrid populations of the genus *Rubus* can provide a source of healthy food and a valuable source of raw materials for the phytotherapeutic industry [1, 2, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 19, 20, 23, 24, 25].

Raspberry, *Rubus idaeus* L., began to be grown in England in the mid-1500s. It is a perennial, thorny shrub, 1-2 m tall, with straight stem, arched towards the top, with fine thorns, which are dense at the bottom and rare or even absent at the top. The leaves are compound, of 3 leaflets on the fertile branches or 7 leaflets on sterile branches, ovate lanceolate, with irregular incisions on the edge, on the underside of the leaf – whitish, because of the hairs. The inflorescences are located at the top of the branches of the previous year or at the axils of the leaves, with white flowers, pentamerous, the petals being equal in size to the sepals, of 1-1.4 cm, with numerous pistils and stamens. The fruits are red, juicy polydrupes with persistent calyx. It is found in clearings, on rocky sides, especially in deforestation zones or fellings on hills and mountains, which are invaded in 3-5 years. It is grown in individual households but also in agricultural plantations for fruit. Along with other berries, raspberries occupy 3100 ha in the Republic of Moldova.

Blackberry, *Rubus fruticosus* L., grows spontaneously in the forest areas, on the edges. The shoots at the top are canaliculate, long, slender. The leaves are quite varied, generally narrow, with elliptical terminal leaflets, ovate or obovate, often small, usually with an elongated tip, upper leaves ovate lanceolate. Lower leaflets - short petiolate. Inflorescence - simple racem, rarely panicle. The flowers are white or pale pink, rarely of a bright pink. It blooms in June-July, bears fruit in August.

Hybrid berry, *Rubus loganobaccus* L.H. Bailey. The original plant was selected from seedlings resulting from the hybridisation of the octoploid blackberry Aurora and a tetraploid raspberry, made in 1969 at the Scottish Horticultural Research Institute, Dundee, UK. The cultivar 'Aurora', which was bred at Corvallis, Oregon, served as the maternal parent. The pollen parent was also bred at the Scottish Horticultural Research Institute, a tetraploid raspberry, 626/67. The plants are characterized by vigorous and sturdy shoots, which, in young plants, are spreading, but in more mature plants – tend towards a more semi-erect habit. The spines are elliptical in shape, dense, and highly pigmented at their base and tip. The leaves are mostly deep green, but there is also some red pigmentation, especially in young leaves, around the margins of older leaves and in the petioles. The compound leaves usually have five leaflets, which are very slightly convex and have a distinct relief between the veins. Suckering in the true botanical sense does not occur in this species, but mature plants commonly produce from approximately 5 to 9 replacement canes from root-stock buds. The fruits are produced on fruiting lateral shoots of about 30 cm in length. They are usually deep red or purplish red and become deep purple when over-ripe, large and of long conical shape. Tayberry fruits are darker than those of Loganberry and are purpler than those of Loganberry, which fruits are redder. The fruits appearance is glossy, with a slight downiness. The plug remains attached when separated from the plant. Ripening starts early and lasts over a long period.

This research was aimed at determining the level of antioxidant activity of leaf and fruit extracts from *Rubus fruticosus* L., *Rubus idaeus* L. and *Rubus loganobaccus* L.H. Bailey, grown under the climatic conditions of the Republic of Moldova.

MATERIALS AND METHODS

The leaves and fruits samples of *Rubus idaeus, Rubus fruticosus* and *Rubus loganobaccus* ′Tayberry Medana′ were collected from the experimental plot of the "Alexandru Ciubotaru" National Botanical Garden (Institute) Chişinău, Republic of Moldova, N 46°97′32.0″ latitude and E 28°88′77.4″ longitude. The collected plant products (leaves) were fixed by dehydration, then ground. They were dried under natural conditions, in the shade. As for the fruits, they were fresh (Figs. 1, 2, 3, 4, 5, 6, 7).

Fig. 1. *Rubus idaeus* with fruits
Source: Own photograph. Original.

Fig. 2. *Rubus idaeus* fruits
Source: Own photograph. Original.

Fig. 3. *Rubus fruticosus* leaves
Source: Own photograph. Original.

Fig. 4. *Rubus fruticosus* fruits
Source: Own photograph. Original.

Fig. 5. *Rubus loganobaccus* fruits
Source: Own photograph. Original.

Fig. 6. Tayberry with flowers and fruits
Source: Own photograph. Original.

Fig. 7. Tayberry with fruits
Source: Own photograph. Original.

The leaves and fruit extracts from *Rubus* sp. were extracted with 60% aqueous ethanol, at room temperature, after 30 min of permanent shaking, the extract was filtered through Whatman no. 2 filter paper by vacuum suction, using Buchner funnel. The procedure was repeated 6 times. The combined extracts were evaporated under reduced pressure to dryness at 40°C and stored at -4°C until analysis.

The total phenolic content of extracts was measured by employing the Folin-Ciocâlteu assay [18]. An aliquot of 250 µl of Folin-Ciocâlteu phenol reagent (10 x diluted), 50 µl of the extract, and 500 µl water, were mixed and for 1 min left to react.

Then *20%* Na_2CO_3 solution, (800 µl) was added and left to react for 2 h (the time is reduced to 30 min at 40°C), and then the absorbance of the mixture was measured at 760 nm (the control was the solution without extract). The total phenolic content was indicate as mg gallic acid per gram of dry plant material.

The 1,1-diphenyl-2-picrylhydrazyl radical (DPPH), which is stable one, was used for the determination of free radical-scavenging activity of the extracts. This radical at an average temperature of 23°C colours the methanol in violet and in the presence of an antioxidant is reduced, producing an uncoloured solution. The use of DPPH provides an easy and rapid way to evaluate antioxidants. Sample stock solutions (1mg/ ml) were diluted to final concentration of 200, 100, 50, 25, 10, 5 and 1µg/ml in methanol.

At an equal volume (0.75ml) of methanolic solution of DPPH (1.5 ml, 20 mg/1), different concentrations of each extract were added. The solutions were kept for 15 min at about 23°C, the absorbance was measured at 517 nm. As control solution served methanol. As negative control, methanol (0.75 ml), and DPPH solution (1.5 ml, 20mg/1) were used. The IC_{50} value was calculated graphically and it denoted the sample concentration, which was required to collect 50% of DPPH free radicals [3].

The antioxidant activity measurement by ABTS assay is a method based on the sample capacity to inhibit the $ABTS^+$ (2.2'-azino-bis(3-ethylbenzothiazoline-6-sulphonic acid)) and as control serves Trolox (the standard antioxidant)[14]. The $ABTS^+$ is obtained as a result of potassium persulfate ($K_2S_2O_8$) reaction. To obtain this, 0.1 ml of $K_2S_2O_8$ (70mM) is put in to reaction with10 ml of ABTS 2mM and left in the darkness for about 14 h at 23°C. By taking 1 ml of the previous solution and thinning it - out in 24 ml of ethanol, the working solution is obtained, the absorbance at $\lambda = 734$ nm must be 0.70±0.02.

The reaction is produced in the measuring cuvette by adding 10 µl of standard to 0.99 ml of $ABTS^+$ radical, as a result, the antioxidants present in the standard inhibit the radical, and reduce the absorbance, and the reduction process is in a quantitative relationship with the concentration of antioxidants present in the sample.

Meanwhile, was prepared a Trolox calibration curve for a concentration range of 2.5 - 30µM and the calculation of the concentration in Trolox equivalents (µM TEAC) was done by the insertion of the inhibition percentage acquired for the sample.

The method of Dinis et al. was used to evaluate the chelation of ferrous ions by the extracts [5].

Briefly, 50 µl of 2 mM FeCl was added to 60 µl of samples (10 mg/ml). The reaction was initiated by the addition of 200 µl of 5 mM ferrozine solution.

The reaction between the samples - 60 µl (10 mg/ml) and 50 µl of 2 mM FeCl was initiated by 200 µl of 5 mM ferrozine solution.

After what the mixture was shaken, kept at 23ºC for 10 min, the absorbance of the solution was taken at 562 nm.

The formula $[(A_0 - A_S)/A_S] \times 100$, was used to calculate the percentage inhibition of ferrozne-Fe^{2+} complex formation, the absorbance of the control is marked by A_0, the extract standard $_{as}$ well. As a positive control EDTA was used.

Data were expressed as mean of three replicates and standard error (SE). Statistical significance ($P<0.05$) was evaluated by the Student's test. AII analyses were performed using GraphPad Prism; version 6.01, 2012.

RESULTS AND DISCUSSIONS

Phenolics are a class of secondary metabolites, which consist of one or more aromatic rings with variable degrees of hydroxylation, methoxylation and glycosylation, influencing the fruit colour, astringency and bitterness. Flavonoids, phenolic acids, tannins and stilbenes are the main categories of phenolic compounds found in the researched berries. The established total phenolic compound concentration in the examined *Rubus* extracts was in the range from 13.97 to 90.84 GAE/g DW. As a result of the research carried out, it was established that total phenolic compounds in the leaf extracts from the studied *Rubus* species varied from 28.70 to 90.84 GAE/g DW, but in fruit extracts – from 13.97 to 45.08 GAE/g DW (Figs. 8 and 9). A high index for the total phenolic compounds was found in the leaf and fruit extracts from *Rubus loganobaccus* 'Tayberry Medana'.

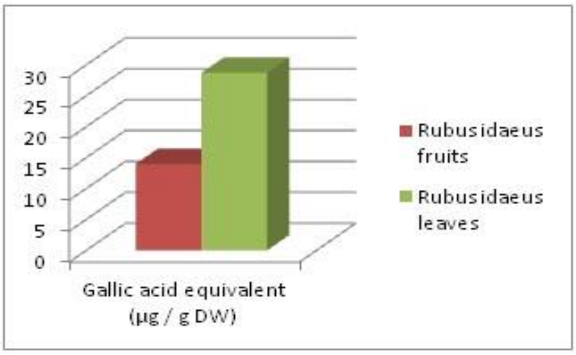

Fig. 8. The total content of phenolic compounds in *Rubus idaeus.*
Source: Own determination.

Many researchers have found a link between the structure of phenolic compounds and their antioxidant properties. The total phenol content of plants has been associated with their antioxidant activity due to their redox properties, acting as hydrogen donors and oxygen unpaired electron acceptors. Flavonoids have the ability to transfer electrons to free radicals, chelation of metal catalysts, activation of antioxidant enzymes and mitigation of oxidative stress caused by nitric oxide.

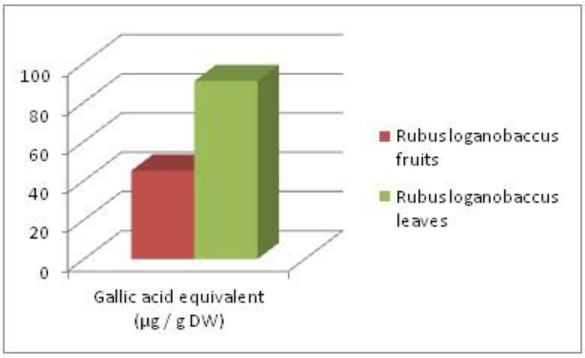

Fig. 9. The total content of phenolic compounds in *Rubus loganobaccus* 'Tayberry Medana'.
Source: Own determination.

Different assays are used to measure antioxidant capacity in foods and biological samples. Currently, the most commonly used methods for measuring antioxidant capacity are: 1,1-diphenyl-2- picrylhydrazyl (DPPH) assay, 2,20 -azino-bis-3- ethylbenzthiazoline-6-sulphonic acid (ABTS) assay, Iron chelating capacity.

Scientists consider that the effect of antioxidants on DPPH radical scavenging is due to their hydrogen-donating ability. In the specialized literature, it has been mentioned that DPPH is a stable free radical and accepts an electron or hydrogen radical to become a stable diamagnetic molecule. A commonly used parameter to measure the antioxidant activity is the IC_{50}, which stands for concentration of antioxidant needed to decrease the initial DPPH concentration by 50%. The higher antioxidant power has the extract, the lower value IC_{50} have.

All results on DPPH radical scavenging of *Rubus* species leaves and fruits extracts are shown in Figure 10, 11 and Table 1. In general, in all assays, the leaf extracts of

Rubus species showed higher values of antioxidant activity than fruit extracts. A high antioxidant activity was found in the leaf extracts of *Rubus fruticosus* and the fruit extracts of *Rubus loganobaccus* 'Tayberry Medana'. It was determined that, the extracts of the *Rubus loganobaccus* 'Tayberry Medana' showed a higher level of free-radical sequestering than the respective extracts of *Rubus idaeus.*

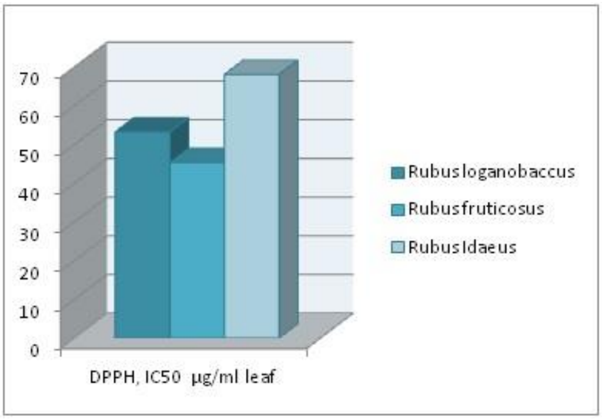

Fig. 10. The antioxidant activity of *Rubus* sp. leaf extracts, DPPH, IC_{50} µg/ml.
Source: Own determination.

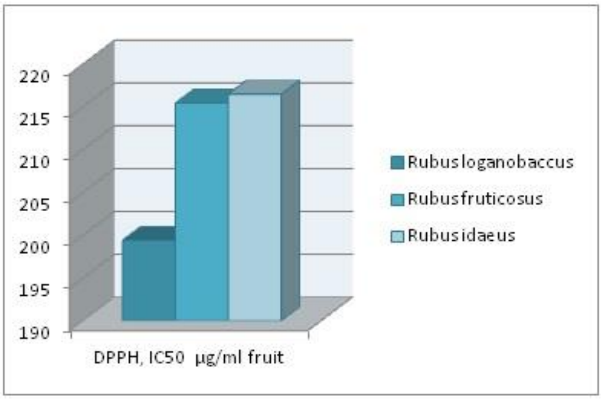

Fig. 11. The antioxidant activity of *Rubus* sp. fruit extracts, DPPH, IC_{50} µg/ml.
Source: Own determination.

The results for scavenging of ABTS radical represented in Figure 12, 13 and Table 1 were in the range from 1.50 ± 0.16 to 42.57 ± 0.45 µM TE/g DW. The ABTS method showed that the extract of hybrid berry (*Rubus loganobaccus*) leaves has the highest antioxidant properties (42.57 µM TE/g DW) and fruits (15.47 µM TE/g DW).

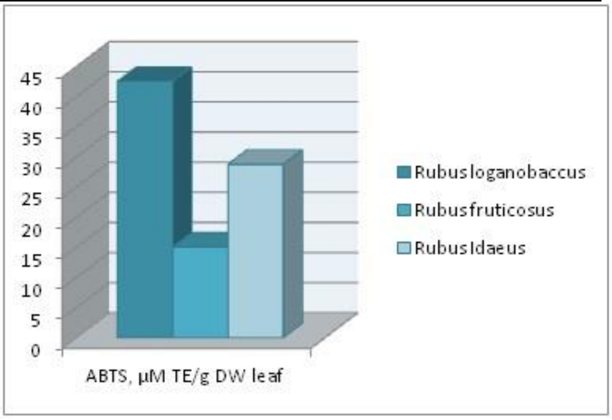

Fig. 12. The antioxidant activity of *Rubus* sp. leaf extracts, ABTS, µM TE/g DW.
Source: Own determination.

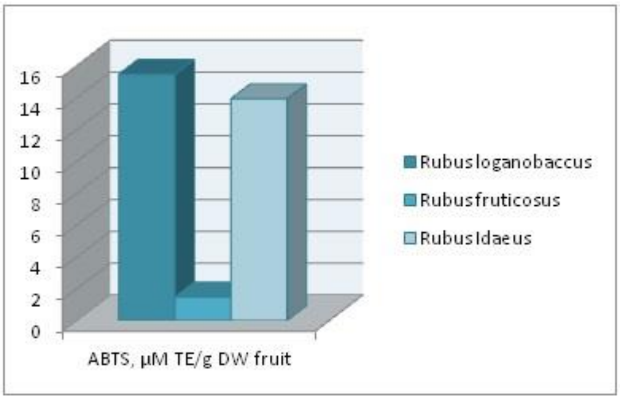

Fig. 13. The antioxidant activity of *Rubus* sp. fruit extracts, ABTS, µM TE/g DW.
Source: Own determination.

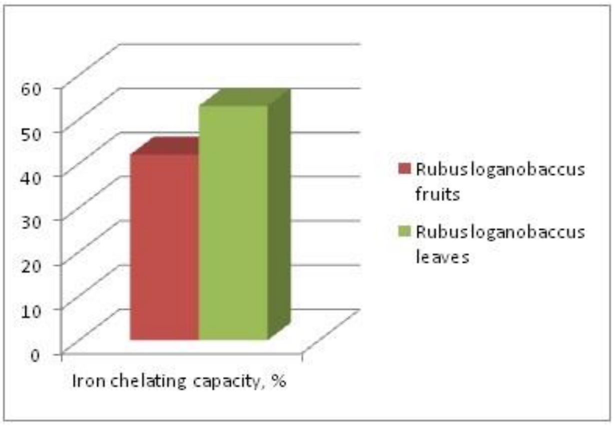

Fig. 14. The antioxidant activity of *Rubus loganobaccus* extracts, Iron chelating capacity, %.
Source: Own determination.

It was found that the iron chelating capacity of *Rubus loganobaccus* 'Tayberry Medana' extracts ranged from 53.06±2.15%, in leaf extract, to 42.07±2.56 (fig.14, tab.1) and was slightly lower in comparison with the Standard EDTA (99.98 ±0.19).

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Table 1. The antioxidant activity of *Rubus* sp. extracts

Dried extract	DPPH, IC_{50} µg/ml	ABTS, µM TE/g DW	Iron chelating capacity, %
Rubus loganobaccus leaf	53.27±3.20^{a}	42.57±0.45 ^{a}	53.06±2.15 ^{b}
Rubus loganobaccus fruit	199.39±2.16^{a}	15.47±1.44^{a}	42.07±2.56^{a}
Rubus fruticosus leaf	45.39±0.94 ^{a}	15.10±0.96	
Rubus frutcosus fruit	215.44=1.54^{b}	1.50±0.16	
Rubus idaeus leaf	68.10±0.74	28.79±0.43^{b}	
Rubus idaeus fruit	216.50±0.39	13.93±0.20^{c}	
Standard Gallic acid	1.50±0.3	-	-
Standard Trolox	5.28±0.9	-	-
Standard EDTA	-	-	99.98±0.19

[1]Mean of three replications ± standard error
[2]Means followed by the different small letters within a column denote significant differences (P<0.05)
Source: Own results.

Some authors mentioned various findings about phytochemical potentials of *Rubus* species. Ekbatan Hamadani et al. [6]. remarked that the total phenolic contents in *Rubus loganobaccus* leaves grown in the field were higher (66.63 ± 1.31 GAE/g) compared with those grown in the greenhouse (65.30 ± 2.56 mg GAE/g), the plants grown in the field contained higher amounts of flavonoids than those grown in the greenhouse (29.35 ± 8.53 and 22.44 ± 3.32 mg QE/g, respectively).
The amount of ascorbic acid of the field grown *Rubus loganobaccus* leaves were higher (EC_{50} - 2.82 ± 0.70 µg/mL) compared to those grown in the greenhouse (EC_{50} - 2.41 ± 0.75 µg/mL).
Veljkovic et al. [23] reported that the total phenolic compounds of wild raspberry, *Rubus idaeus*, leaf methanolic extracts ranged from 59.68 to 96.83 mg GA/g, the flavonoid concentration was 7.02-7.53 mg Ru/g, total tannins in the methanol extracts 0.73-1.27 mg/mL, anthocyanins 4.43 to 9.00 µg/L, antioxidant activity 110.17-199.18 µg/mL, inhibitory activity between 2.5-20.00 mg/mL.
Sharma & Kumar [16] reported that the reducing power of *Rubus ellipticus* fruits extracts was significant and fluctuate from 81% to 93% antioxidant activity. The measurement of antioxidant activity in the *Rubus ellipticus* ethanolic fruit extracts showed a DPPH radical scavenging ranging from 28.68% to 68.66%.
Zeidan & Oran [25] found that the *Rubus sanguineus* leaves ethanolic and methanolic extracts showed the highest DPPH activity, about 99% (at the concentration of 15 mg/ml). The ethanolic fruit extract of the same species showed a similar percentage, but the DPPH scavenging activity of methanolic extract were 95%.
The aqueous leaf extract was the lowest (83% DPPH activity) at 15 mg/ml in comparison to the organic extracts. The fruit extracts showed 90% DPPH activity, still less than that of the organic extracts.
According to the results obtained by Orhan et al. [11] "the total phenolic content in *Rubus sanctus* flower extract was 31.01 GAE/g extract, in leaf extract 26.27.01 GAE/g extract and lowest level was observed in shoot extract 25.54 mg GAE/g extract, the radical scavenging activity of studied extracts (DPPH inhibition) were 81.4%, 85.6%, 87.2% respectively".
Moon et al. [8] found that "*Rubus crataegifolius* fruit methanol extract showed strong antioxidant activity (75.04%, 50%), as compared with vitamin C (79.9%, 54.1%), by the DPPH and H_2O_2 method, respectively. Zayova et al. [24] mentioned that, free radical scavenging activity was 38% higher in *Rubus loganobaccus* fruit extracts of *in vitro* propagated plants, compared with extracts of traditionally cultivated plants.
′Tayberry′ cultivar of the same species showed similar trend for *in vitro* propagated plants regarding water-soluble antioxidant capacity of fruit extracts. Traditionally cultivated plants had WS-AOC 46% lower in their extracts.
In vitro cultivated plants of ′Tayberry′ cultivar showed a higher content of total phenols by 23% in their fruit extracts compared to the content of fruits derived from traditionally cultivated plants. For the flavonoids the percentage was by 34% higher.
Studies conveyed by Ştefănuţ et al. [20] showed a content for the *Rubus fruticosus* fruit extracts as follows: anthocyanins -1,343 mg/L, phenolics - 3,284 mg GAE/L and antioxidant activity - 17.3 (µM TE/gFM)
Najda & Labuda [10] reported that *Rubus fruticosus* fruits had a content of total phenolic-101,947, anthocyanin contents - 38,021 and flavonoid contents - 4,291 per 100 grams of fruits. The values for antioxidant activity of fresh fruits for DPPH,

FRAP and ABTS were 1,293 μMTE/g, 971 μMTE/g and 517 μMTE/g respectively.

CONCLUSIONS

The results of our research indicate that all *Rubus* plant extracts exhibit a significant free radical scavenging activity.

The leaf extracts of *Rubus* sp. showed the highest values of antioxidant activity (DPPH — IC_{50}) = 45.39 — 68.11 μg/ml; ABTS — 42.57 μM TE/g dry matter, iron chelating capacity — 53.06 %).

This study suggests that *Rubus* sp. leaf extracts exhibit great potential for antioxidant activity and may be useful for medicinal purposes.

We concluded that *Rubus loganobaccus* ′Tayberry Medana′ is an important source of natural antioxidants, which might be helpful in preventing some negative effects caused by oxidative stress.

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RESEARCH ON THE QUALITY OF HONEY AND POLLEN OBTAINED DURING THE BEEKEEP FROM BOIAN VILLAGE SIBIU COUNTY, ROMANIA, IN VIEW OF THE ECOLOGICAL CERTIFICATION OF BEEKEEPING PRODUCTS

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Abstract

The present paper aimed to perform instrumental analyzes on actual hive products: six varieties of honey and three varieties of pollen, extracted from the apiary in the village of Boian, Bazna commune, Sibiu county, in order to certify them as organic products. The hive consists of 130 bee families, the form of beekeeping is stationary and pastoral. The type of crates is 90% of the vertical Dadant type, and the remaining 10% of the horizontal Dadant type. Bee families benefit from adequate microclimate conditions and care. The geographical factors and the honey base in the village of Boian, but also the pastoral movement make possible the good functioning of the apiary and to obtain important incomes following the beekeeping activity. In order to ecologically certify the bee farm, the following conditions are met: the apiary is well organized and has been operating for 25 years and can be reconverted from conventional apiary to organic apiary, there is an ecological honey base in the areas where the harvest is done, environmental conditions are optimal in the village of Boian, and the bees benefit from organic hives and quality ecological food in winter.

Key words: *pollen, honey, quality, product certification*

INTRODUCTION

Honey is a sugary substance that bees produce by collecting floral nectar using the invertine in their goiter [6]. The resulting product is deposited in honeycombs, where the process of transformation into continuous honey, resulting it as a natural product being in a permanent evolution [12,13,14].

Romania produces an average of 22,000 tons of honey annually, ranking us as the fourth country in Europe. Nationally, about 40,000 beekeepers are registered, with a population of 900,000 bee families [1].

The latest data shows that Romania is importing between 3,000 and 6,000 tons of honey annually, having almost 30-35% of domestic consumption. Honey consumption per capita is between 800-900 g of honey, thus being among the last countries in Europe [1].

The Hașu Boron apiary is located in Bazna commune, Boian village (Photo 1) and was founded in 1993, with 30 multi-storey Dadant hives. In 2020, it reached a total of 130 Dadant type hives and horizontal boxes. The form of hives is also stationary 50 hives and pastoral with 80 hives. The exploited bee is *Apis carpatina*, with a native queen from the Romanian Beekeepers Association. The queen is in operation between 3 and 4 years depending on it's productivity. The queens are marked with specific colored markings per year: 2020-blue, 2019-green, 2018-red. In a hive the bee population is between 10,000-50,000 individuals, of which about 500-1,000 drones, a queen rarely 2 queens (which never meet) and the rest stating among the working bees population.

The products obtained on the apiary: honey with the following varieties: (polyflora, raspberries, rapeseed, manna, acacia, mountain fir, sunflower), pollen, propolis, royal jelly and wax. Boian commune, like other areas in Sibiu county, is propicious to beekeeping (Photo 2), and the honey base in

Sibiu county has been studied over time by specialists who certify this [2, 3, 4, 5].

From May to August, some of the bee families in the apiary are transported to the pastoral in Dolj county, Desa locality, to pick acacia, and after two weeks in Covasna county to raspberry. The hives from the village of Boian at the acacia II harvest from the hayfields around the town of Mediaș in Sibiu County. In July, it leaves for pastoral care in Tulcea County in Ciucorova, located in the linden forest, considered to be the largest in Europe. At the beginning of August, it goes to pastoral care in Ialomița County, in Tăndărei to pick sunflowers. From the middle of August, in the interval of 15-20, we return to the village of Boian, to harvest hay from which the assortment of honey of the same name is harvested.

Photo 1. Location of apiaries in Boian village
Source: Google earth view [7].

Photo 2. Picture of Boian village
Source: Original.

The products obtained in the hive are capitalized on the Romanian market, at private customers and at a processor in the city of Blaj. The price of honey varies between 20-35 lei/Kg for private customers and between 8-14 lei Kg for processors. Wax is also used at a processor in Bistrita at the price of 40 lei/Kg. The pollen is sold to local customers at the price of 40 lei/Kg. Propolis is sold as a tincture at a price of 10 lei/20 ml.

In this context, the purpose of the paper is to analyze six varieties of honey and three varieties of pollen, extracted from the apiary in the village of Boian, Bazna commune, Sibiu County, to certify them as organic products.

This research work continues the studies on honey quality carried out over the years by the author in several specialized articles [15, 16, 17, 18, 19].

MATERIALS AND METHODS

In order to reconvert the apiary and to certify honey as an ecological product, we performed laboratory analyzes on the six varieties of honey: rapeseed, polyflora, acacia, lime, honeysuckle, sunflower.

Three pollen varieties were also analyzed: dandelion, rapeseed, hay, and six types of honey most found in the spontaneous flora of Boian village.

All samples were analyzed in aqueous extract for both honey and pollen varieties. About 10 grams of sample (honey and pollen), dissolved in distilled water prepared before analysis, were used.

In order to determine the quality of honey and to prove its authenticity in order to certify it as an ecological product, the following categories of analyzes were performed: acidity index, in the presence of phenolphthalein color indicator and titration with 0.1 N NaOH; the electrical conductivity of honey related to the concentration of inorganic salts, organic acids and proteins, the pH of honey is important during honey extraction and preservation, and it influences the texture, stability and shelf life of honey and the determination of water content. For

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pollen, pH, conductivity, and acidity analyzes were performed for analysis.
The water content was determined using the refractometer, and the acidity index by titration, in fact, the pH was determined using the Loger Data device to which the pH sensor was attached (Fig. 3).

RESULTS AND DISCUSSIONS

Assortments of honey on which the instrumental analyzes were performed (Photo 3) are the following ones:
-***Rapeseed*** honey. The harvest took place in April 2020. As the environmental conditions of last year were unfavorable, the production of this honey assortment was quite low, the harvest depended on the weather conditions and the flowering period of rapeseed in Boian.
-***Acacia*** honey. The assortment of honey for analysis was obtained at the end of May-beginning of June 2020 in the Boian apiary. This honey has a whitish color and aroma specific to acacia.
-***Mountain*** honey was another variety of honey analyzed, collected by bees from the apiary in the summer of 2020 from spontaneous flora, ***polyfloral honey (hay)*** collected from the Boian area and after the organoleptic examination we can say that it is the best in taste.
-The ***sunflower honey*** obtained after harvesting from the fields near Boian village is also from 2020, the taste being astringent and very pronounced. In the crystallization process, the formed particles are larger and harder.
-**Honeysuckle** honey was obtained in 2020 and is considered the sweetest variety of honey.

Photo 3. The six varieties of honey under analysis
Source: Original.

As a water content, sunflower honey had the lowest water content (17.8%), acacia (18%), polyflora (18.2%) and the highest water content was rapeseed honey (18.4%).
The dry matter content was highest in sunflower honey (83.1%), followed by rapeseed (81.5%), polyflora (81%) and acacia with the lowest dry matter content (80.2%). (Table 1).
The results obtained are within the norms regarding the quality of honey STAS SR 784-3: 2009 in Romania and Regulation 1151/2012 of the Council of Europe.
A honey certified as natural must not have a water content of more than 20% [8, 20, 21]. It is known that bees "cap" honeycomb cells and store honey only after the water has evaporated. This analysis is another criterion for recognizing natural honey that goes through the "sugaring" stage during storage.

Table 1**.** Determination of water content

The type of honey	% SU	Refraction index	% water
Lime honey	81,5	14,896	18.4
Rapeseed honey	81	14,895	18.2
Sucklehoney honey	80.2	14,896	18
Mountain honey	83.1	14,894	17.8
Sunflower honey	86	1,4894	18,9
Acacia honey	83	1,4895	18,8

Source: original.

Table 2. Determination of acidity index

Honey type	Quantity(g)	Distilled water (ml)	Phenolphthalein (drops)	NaOH titration (ml)
Lime honey	10,228	30	3	1.51
Rapeseed honey	12,441	30	3	1.89
Mana honey	10,756	30	3	2.8
Mountain honey	10,374	30	3	2.9
Sunflower honey	10,124	30	3	2.0
Acacia honey	10,098	30	3	1.4

Source: original.

The results obtained from the analysis of the acidity index can be interpreted as follows: acacia honey 1.51 degrees of acidity; sunflower 1.89 degrees of acidity; polyflora 2.8 degrees of acidity; rapeseed 2.9 degrees of acidity; this represents ml of NaOH used for drawing in the presence of the phenolphthalein color indicator (Table 2). Following the interpretation of the data, it can be concluded that all assortments are natural and the values fall within the norms in force STAS SR 784/3–2009.

Table 3. Determination of electrical conductivity

The assortment of honey	Conductivity electrical µS · cm-1
Lime honey	263
Rapeseed honey	212
Honeysuckle honey	226
Mountain honey	208
Sunflower honey	195
Acacia honey	377

Source: original.

The electrical conductivity of honey was directly related to the concentration of inorganic salts, proteins, and organic acids [5-7]. Depending on the floral origin, this parameter indicates the variability for differentiating the floral origin [9-11]. The results obtained are according to the quality standards SR 784-3: 2009, 2009 in Romania and Regulation 1151/2012 of the Council of Europe (Table 3).

Table 4. Determination of pH

Honey assortment	pH
Lime honey	5.3
Rapeseed honey	5.6
Mana honey	5.2
Mountain honey	6.0
Sunflower honey	5.1
Acacia honey	4.8

Source: original.

The chemical reaction of honey due to its rich content in organic acids is acidic.
The pH was measured with a pH meter of 340-B/SET1, from a solution containing 10.0 g of honey sample in 75.0 ml of ultrapure water (Table 4).
The pH of the honey was between the range of values 4.8-6 pH units (Photos 4-9).

Photo 4. pH of linden honey
Source: Original.

Photo 5. pH of rapeseed honey
Source: Original.

Photo 6. pH of hand honey
Source: Original.

Photo 7. pH of mountain honey
Source: Original.

Photo 8. pH of sunflower honey
Source: Original.

Photo 9. pH of acacia honey
Source: Original.

The pH value is of great importance during the extraction and storage of honey. It influences the texture, stability and shelf life of honey, and the values obtained from the analyses are in accordance with SR 784-3: 2009, 2009 in Romania and Regulation 1151/2012 of the Council of Europe.

The pollen is in the form of a very fine powder, variously coloured, depending on the species (Photos 10-12).

It is the main source of protein food for bees, but can also be used in human nutrition [13, 22].

Photo 10. Dandelion pollen grains
Source: Original.

Photo 11**.** Haystack pollen grains
Source: Original.

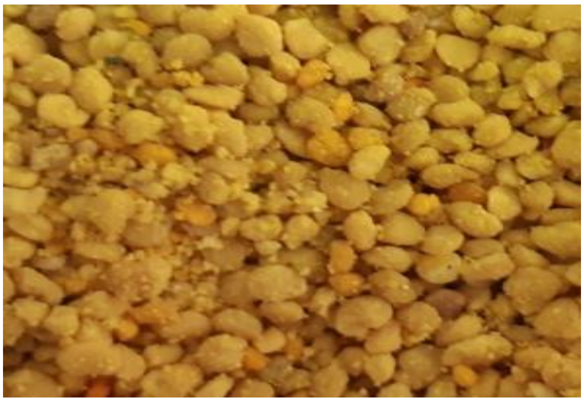

Photo 12. Rapeseed pollen grains
Source: Original.

The pollen is collected from the floral anthers, then the bee with the help of the forelimbs collects the pollen from the head, from the mouth pieces, but also from the neck region, and with the middle limbs it collects from the thorax and abdomen. After collecting all the pollen from the body, the bee stores it in the hollow of the pollen basket (corbicula).

The results of the analyzed pollen varieties are shown in Table 5.

Table 5. Results of the analyzes of the three pollen varieties

Characteristics	**Dandelion pollen**	**Rapeseed pollen**	**Haystack pollen**
Quantity g	10.38	10.386	11.014
Ph	4.3	4.3	4,2
Electrical conductivity, microsiemens x 10^2, minimum	156	214	350

Source: original.

Photo 13. Preparation of pollen samples for analysis
Source: Original.

Photo 14. Conductivity analysis of the three pollen varieties
Source: Original.

Photo 15. pH value of dandelion pollen
Source: Original.

Photo 16**.** pH value of grassland pollen
Source: Original.

The photos 13-17 reflect how the analyses were made on the three pollen varieties.

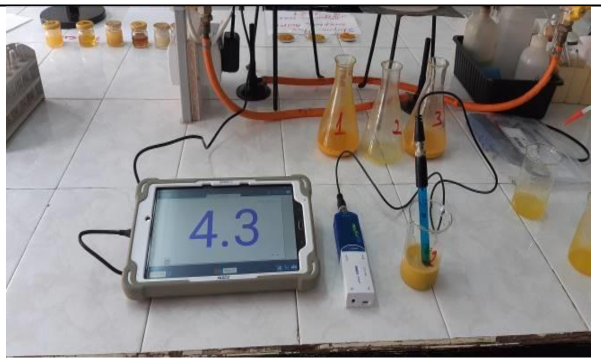

Photo 17**.** pH value of rapeseed pollen
Source: Original.

Pollen has in its composition all the minerals present in our body, but also most of the vitamins and the main enzymes and proenzymes, along with many other active elements, vital for health. After performing pH analyzes we can conclude that it is acidic as well as honey, with values of 4.2 and 4.2 pH units.

CONCLUSIONS

Through this paper we aimed to highlight the natural qualities of honey varieties under analysis in order to certify it as an organic product.

Through the physico-chemical analyzes performed in the laboratory: acidity, pH, conductivity and refractive index, we can conclude that all six varieties of honey are natural, without fakes and fall into the category of natural honey according to current standards SR 784-3: 2009, 2009 in Romania and Regulation 1151/2012 of the Council of Europe. After the conversion of the apiary, the honey and the other products of the hive can be certified as ecological products.

Following the analyzes performed and after the interpretation of the obtained results, we certified the fact that both the honey and the analyzed pollen are produced by bees in their natural state without the intervention of the beekeeper.

In conclusion, it was certified that the bee families found in the bee farm in the village of Boian harvested the nectar of the flowers, obtaining the six varieties and then transformed the sucrose from the nectar into glucose and fructose.

After analyzing the water content, we can conclude that all six varieties of honey are natural, because the values obtained are below 20% water, which shows that honey is natural and the varieties can be certified as organic products.

The phenomenon of "Sugaring" was confirmed during the storage of honey, this being another criterion for recognizing natural honey.

In order for the products obtained in the Boian apiary: honey, propolis pollen, royal jelly and wax to be certified as organic products, the following steps will be completed by the end of 2022 in order to certify them:

-Accreditation of the conventional apiary as an ecological apiary
-Ecological registration of honey
-Conversion from conventional apiary to organic apiary
-Purchase of water-based varnish-painted boxes
-Acquisition of organic honeycombs.
-Administration of treatments for bees based on organic substances.

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MANAGEMENT AND VALORIZATION OF AGRICULTURAL WASTES FROM WINE PRODUCTION USING STATISTICAL ANALYSIS TO OBTAIN NOVEL FOOD

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Abstract

Proper management and valorization of waste from wine production is an important and difficult issue for winemakers. This type of waste contains valuable biologically active substances (dietary fiber, fats, polyphenols, etc.). With proper treatment, this waste can be used to produce new functional foods. The aim of the article is to determine the exact amount of grape pomace powder (GPP) in cakes using statistical data processing using the "Correspondence Analysis" method and using an initial model (second-order polynomial). Determination coefficient (R2), model coefficients, their standard error (SE), t-statistics (tStat), p-value, Fisher's criterion (F) are determined. An analysis of the residuals is made, which are determined by the difference between the values of the model and the actually measured ones. Stat Soft Statistica 12 (Stat Soft Inc.) software was used to create these models. The determined values are: coefficient of determination R^2=0.89-0.92; F (2.47)<$F_{critical}$; SE=0.01-0.09, models describing the indicated dependences were obtained. Using the applied linear programming algorithm, it is determined that the optimal amount of GPP=4.72%.

Key words: *management of agriculture, by-products, novel foods, statistical analysis*

INTRODUCTION

The concept of a circular economy was promoted due to a reassessment of the production methods used in the 1980s, and it was also necessary to pay attention to industrial ecology and environmental protection. Bio economy is a new concept that Europe began to pay active attention to in the early 2000s. It is defined as the production of various renewable biological resources and their transformation into novel foods, feed, biochemical and bioenergy products [9].
The food industry is playing a crucial role in the new era, especially during the COVID-19 pandemic crisis. It is essential to reduce food waste to low levels, taking into account its environmental and economic impact. This can be done by applying technologies such as dehydration, microwave-assisted extraction, ultrasound-assisted extraction, green extraction, etc. [3,4,6], which ensure food safety and recovery of biocaitus compounds from by-products after food processing, and their reuse in the food chain [12].
In recent years, food waste has been most often used to produce new functional foods enriched with bioactive substances. In addition to obtaining new products, there are technologies in which waste is added to improve existing foods. Wine production is of great importance in agriculture and the agro-industrial sector worldwide. Grapes are one of the most important fruit crops grown worldwide.
In 2018 grape production is estimated at about 77.8 milion tones [1]. During winemaking, a large amount of waste is created, which large producers have to deal with. Grape pomace (GP) is the main by-product of the wine industry, which is equal to 250 g/kg of pressed grapes and dry matter in stalks (~20 g/kg), seeds (~470 g/kg), skin and pulp (~510 g/kg) [9,2,17]. GP is a major source of

bioactive substances, especially polyphenols, lipids, proteins, dietary fiber and minerals [5,10,13,16]. GP can be a good alternative with huge potential for the production of many organic products (Fig. 1) [1].

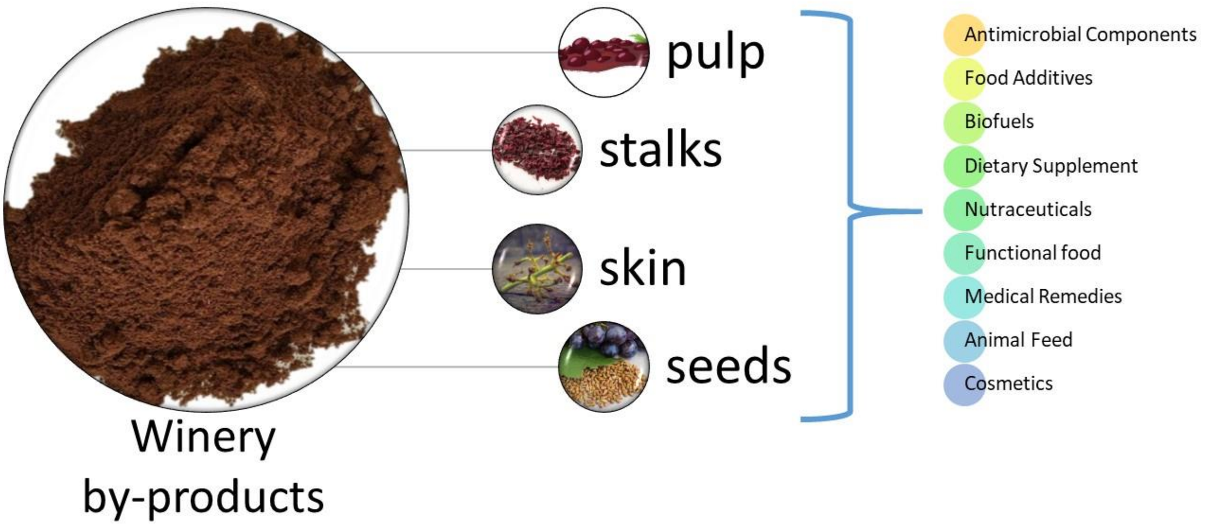

Fig. 1. Components of grape pomace and opportunities to produce many byproducts
Source: Own design.

From the available information in the scientific literature, we found that most often the amount of GP added to food products is based on sensory analysis of products.

As far as we know, there is no information in the scientific literature to determine the exact (optimal) amount of GP in cake products using statistical analysis.

Therefore, the aim of this article is, using an appropriate mathematical model and calculations, to determine the exact amount of GPP in cake products and thus to establish proper management and valorization of agricultural waste from wine production.

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MATERIALS AND METHODS

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The cakes are made with flour type T-550. The grape pomace powder (GPP) is derived from Muscat Hamburg grapes. The technological scheme described by Velioglu et al., 2017 [15] was used, with some modifications. Detailed data on the physicochemical and organoleptic characteristics of the studied products are presented in Nakov et al., 2020 [10].

Figure 2 shows a general view of a cake with the addition of GPP. As the grape seed supplement increases, the color of the product visibly changes to darker.

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a) Control b) 4% GPP c) 6% GPP d) 8% GPP e) 10% GPP

Fig. 2. Changes in the surface characteristics of a cake with GPP - general view
Source: Own design.

Table 1 shows the characteristics used, which vary depending on the amount of grape seed flour added to the cakes. The following were used: 5 color components from Lab and LCh color models, which were obtained after conversion from the RGB model; color difference ΔE; a total of 11 color indices, according to Pathare et al., 2013 [11]; 5 organoleptic indicators; 15 physico-chemical characteristics of the product.

Table 1. Cake's features used

Feature	Meaning	Feature	Meaning
F1	L	F21	Lipids, %
F2	a	F22	Proteins, %
F3	b	F23	Total Dietary Fibre, %
F4	C	F24	Peak Viscosity, Pa.s
F5	h	F25	Breakdown Viscosity, Pa.s
F6	ΔE	F26	Anthocyanins, mg/kg DM
F7	YI	F27	TPC, mg GAE/g DM
F8	WI	F28	DPPH, umol TE/g DM
F9	BI	F29	FRAP, umol TE/g DM
F10	SI	F30	Appearance
F11	CIRG	F31	Taste
F12	COL	F32	Aroma
F13	CI	F33	Odour
F14	ECB	F34	Texture
F15	FCI	F35	Overall Acceptance
F16	WL	F36	Hardness, N
F17	PACI	F37	Springiness
F18	pH	F38	Cohesiveness
F19	Moisture, %	F39	Chewiness, N
F20	Ash, %	-	-

Source: Own calculation.

The selection of informative features was made using the "Correspondence Analysis" method [8]. This is a method that determines the relationships between two data sets. It is applicable to matrices whose elements are the frequencies of simultaneously observed events of the respective classes of the two factors, represented by rows and columns of the table. The obtained results are entered in the vectors r_i and c_j. The values of the weights by rows and columns w_i and w_j are obtained from these vectors (equation 1):

$$w_i = \{r_i\} \qquad w_j = \{c_j\} \qquad (1)$$

Those traits that have weight coefficients with values above 0.9 are selected. A vector of signs is organized from them. The possibility of the Correspondence Analysis method is used to determine the dimensions of a data set. This feature was used to reduce the data volume of the resulting feature vector represented as FV=[D_1 D_2]. An initial model (second-order polynomial) was used, which is more often used in the analysis of products of biological origin [7], describing the relationship between selected characteristics of cake products of the type (equation 2):

$$z = b_0 + b_1x + b_2y + b_3x^2 + b_4xy + b_5y^2 \quad (2)$$

where x and y are independent variables; z – dependent variable; b – model coefficients.
Coefficient of determination (R^2), model coefficients, their standard error (SE), t-

statistics (tStat), p-value, Fisher's criterion (F) are determined. An analysis of the residuals is made, which are determined by the difference between the values of the model and the actually measured ones.
The coefficients of the model and their standard error are determined, and each of them is analyzed depending on the value of the p-level compared to the significance level α. Non-informative coefficients (those with p>α) were rejected by the model. The significance of the coefficients is determined by Student's criterion, and the adequacy - by Fisher's criterion. Stat Soft Statistica 12 (Stat Soft Inc.) software was used to create these models.
A linear programming algorithm was used to determine the appropriate amount of GPP. This algorithm is implemented through the linprog function in the Matlab software system (The Math Works Inc.). Linear programming is the solution of the problem of finding a vector "x" such that the linear function fTx, with linear constraints (equation 3 and 4):

$$\min_x f^T x \quad (3)$$

to be performed under one of the conditions:

$$Ax \le b \qquad A_{eq}x = b_{eq} \qquad l \le x \le u \quad (4)$$

An "Interior-point-legacy" algorithm was used. This algorithm is applied when solving linear programming problems for which the simplex method is not suitable. The algorithm arrives at an appropriate solution by traversing the inner part of the data region [7]. Preliminary analyzes have shown that the other more commonly used algorithm "Dual-simplex", implemented using the linprog function, is not suitable for use in the solution of the problem. All data were processed at a level of significance α=0,05.

RESULTS AND DISCUSSIONS

A selection of features has been made using the Correspondence Analysis method. Figure 3 shows graphically the result of this analysis. The graph shows that all the individual color components are affected by the change in the amount of grape seed flour (GPP). CIRG, FCI, WL are excluded from the color indices. Only four of the organoleptic indicators were selected. Most of the physico-chemical parameters are removed in this selection.

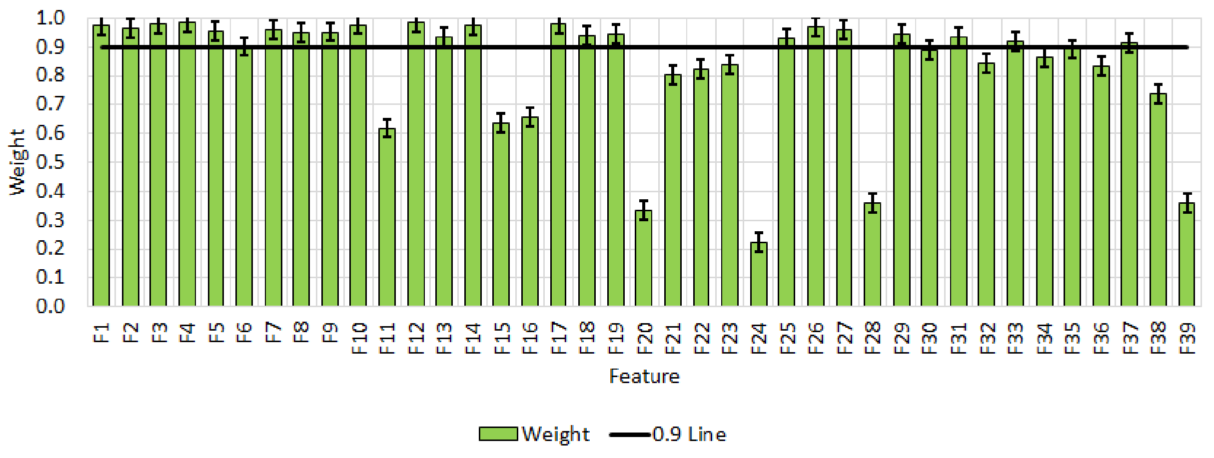

Fig. 3. Results from feature selection with "Correspondence analysis" method
Source: Own results.

From the selected characteristics of a cake with the addition of grape seed flour (GPP), a feature vector is composed, containing those that have a weight coefficient greater than 0.9. The vector contains a total of 25 features and has the following form (equation 5):

FV=[F1 F2 F3 F4 F5 F6 F7 F8 F9 F10 F12 F13 F14 F17 F18 F19 F25 F26 F27 F29 F39 F31 F32 F35 F37] (5)

The dimensions of the feature vector were calculated using the correspondence analysis method. Both dimensions describe the

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variance in the data by over 96%. A feature vector containing the two data dimensions FV=[D_1 D_2] was obtained. Models describing the functions $D_1=f(D_2)$ and $GPP=f(D_1, D_2)$ are defined.

After removing the insignificant coefficients with $p>\alpha$; coefficient of determination $R_2=0.89-0.92$; $F(2.47)<F_{critical}$; SE=0.01-0.09, models describing the indicated dependences were obtained.

The model describing the dependence $PC_1=f(PC_2)$ has the form (equation 6):

$$D_1 = -44.75{D_2}^2 + 4.41D_2 + 0.02 \qquad (6)$$

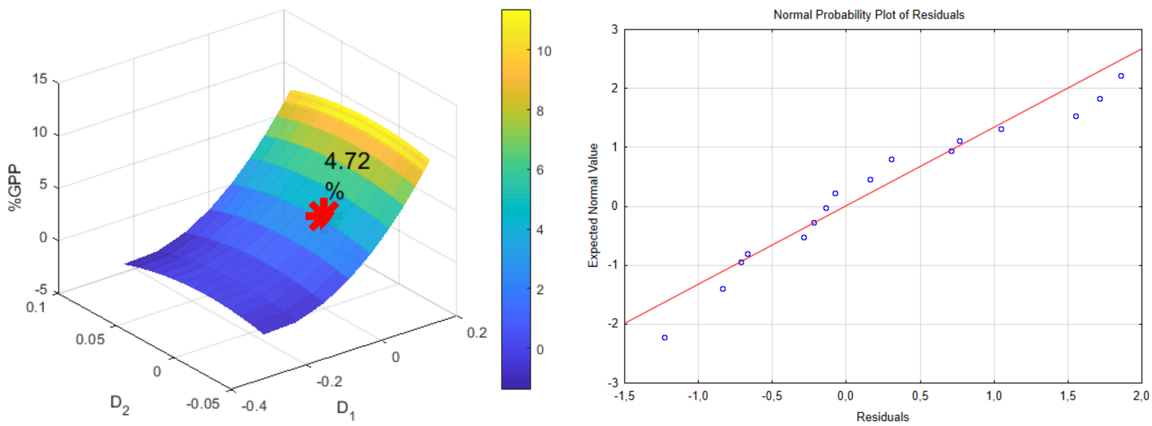
where PC_1 and PC_2 are denoted with D_1 and D_2, respectively.

The GPP quantification model has the form (equation 7):

$$GPP = 5.4 + 38.37D_1 + 67.33{D_1}^2 - 280.4{D_2}^2 \qquad (7)$$

Applying an algorithm for linear programming, an optimal amount of GPP = 4.72% was determined.

Figure 4 shows graphically the resulting model and the appropriate amount of GPP. A normal probability graph of the residuals of the obtained models is shown. Since the points are located close to the straight line, the residuals can be considered to have a distribution close to normal and it can be assumed that the prerequisites of the regression analysis are fulfilled. As can be seen from the distribution of the residuals, in the normal probability graph, they are close to the normal distribution and it can be considered that the prerequisites of the regression analysis are fulfilled.



a) Model

b) Normal probability plot of residuals

Fig. 4. Determining the optimal amount of GPP
Source: Own results.

The obtained results complement those of the available literature. The required amount of GPP=4.72% obtained is in the range of 4-6%, as indicated by Nakov et al., 2020 [10]. Theagarajan et al. 2019 [14] prove that low amounts of GPP improve the nutritional and sensory characteristics of cakes. The method proposed in the present work with the combined use of data from physicochemical, color and organoleptic characteristics of cakes, which are reduced, improves the known ones, as the amount of GPP is refined so as not to violate these characteristics of the final product.

CONCLUSIONS

In the present work, by using a total of 25 characteristics obtained from physico-chemical, color and organoleptic analyzes of cakes, combined in a vector of features and reduced, through a mathematical model and appropriate calculations, the optimal amount of GPP in cakes is determined. Through the proposed mathematical models, an accuracy of up to 92% can be achieved in determining the allowable amount of GPP, which is 4.72% for cake products.

The “Interior-point-legacy” algorithm used in the present work is suitable within the framework of the problem to be solved and the data used. For example, the "dual-simplex" algorithm is not suitable for the analyzed data, which was found in preliminary analyzes.

As a result of the analyzes and calculations made, it can be considered that there is no universal statistical method for determining the amount of additives in cake products. The choice of method depends largely on the nature of the data obtained, their type and distribution.

As a recommendation for practice, as well as for further research, ways can be sought to generalize the mathematical apparatus to be used in determining the optimal amount of GPP additives in cakes. In this way, proper management and valorization of agricultural waste from wine production will be established.

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INTERCONNECTION AND INTERDEPENDENCE OF KEY ECONOMIC SECTORS - AGRICULTURE AND TOURISM IN THE CONDITIONS OF A PANDEMIC CRISIS

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Abstract

The rural development policy in Bulgaria is aimed at achieving sustainable development of the economic sectors, as the rural area is a place for development not only for agricultural activities, but also it offers good prospects for economic development on a regional scale, through adequate business support, job creation and tourism development. Therefore, the interconnection and interdependence between the two economic sectors is especially important to find opportunities for the development of alternative tourism with the formation of unique tourism products and the application of environmentally-friendly agricultural practices in order to achieve higher living standards and economic benefits for local communities. The problem is that the current pandemic conditions of last year and this year impose a number of restrictions to a greater or lesser extent on each of the economic sectors. The aim of our research is related to the study of interconnection and interdependence of key economic sectors – agriculture and tourism in crisis conditions. The research methods used in the study include: basic scientific research methods, questionnaire survey, summary and synthesis, logical method, tabular and graphical presentation of characteristics and trends. The results of the research can be systematized in several directions: analysis of the connections and interdependence of the sectors through the opportunities for creation of unique tourist products and through diversification of the activities in the rural areas. In conclusion, the pandemic inevitably affects the economic sectors, with greater constraints on the tourism business, where the preferences of potential tourists are focused on domestic alternative tourism. In the construction of unique and specific tourist products in rural areas, the relationship agriculture – tourism is strongly emphasized in terms of requirements for clean and healthy foods, incl. organic food or the purchase of local food products from the region. The diversification of activities in rural areas through the development of tourism provides an opportunity for the development of entrepreneurial initiatives. The strong connection and interdependence between the economic subjects in the indicated economic branches of key importance is fully manifested in a good combination of the interests of all participants concerned in the process of development of the specific territory/region.

Key words**:** *Covid 19, interconnection, interdependence, agriculture, alternative tourism, rural areas, Bulgaria*

INTRODUCTION

There have been pandemics in human history before, but Covid-19 is the first pandemic in the age of globalisation. It follows that the virus spreads more quickly and easily, and that coping with it requires a coordinated effort at global level [3]. In economic terms, among the most affected by the global pandemic is undoubtedly the tourism sector, which until before the advent of COVID-19 was one of the main drivers of global economic development [17]. According to Popescu et al., tourism is a real opportunity for business development and strengthening of the local economy, due to which it has a socio-economic impact and an impact on the environment [18]. It has been proven that tourism is one of the most dynamic sectors of the world economy with a profound impact on the economic, social and cultural development of many countries [19, 20]. Bulgaria is considered a little-known, safe and stable tourist place located near Western Europe. At the same time, its imposition as a destination of alternative tourism in a separate or combined tourist product is a condition for sustainable economic and social development with environmentally-friendly solutions. The high degree of landscape diversity, as well as that of the cultural and historical heritage contribute to the formation of almost unique tourist products for individual settlements and micro-districts [12]. The industry generates approximately 1/10 of the turnover of the world economy [24]. The essence of tourism is the understanding of an economic sector associated with many industries (agriculture, food industry, etc.), and this is a fact that unconditionally requires mastering the ecological and social balance in a particular tourist destination or location. In modern conditions, tourism in general has become an important factor in improving the quality of life and maintaining the competitiveness of business practices in many areas through the development of sustainable alternative tourism and the introduction of environmentally-friendly agricultural practices.

According to the national legislation (Bulgarian Rural Development Programme 2014-2020) the definition of rural areas at the municipal level (LAU 1) includes the territory of 231 municipalities (out of a total of 265), in which the largest settlement has a population of up to 30,000 people. Thus, rural areas occupy 81% of the territory and 39% of the country's population. In the rural areas of Bulgaria, in addition to villages, there are many small towns (Ministry of Agriculture and Food, 2014). In general, in most rural municipalities in Bulgaria there are unfavourable demographic, social, cultural and economic problems. Their solution is at the heart of local initiatives (e.g. the RDP Leader approach) and the search for the application of European models for mobilising available resources, creativity, entrepreneurship and preserved traditions. In recent years, the application of a number of ideas of the Green Revolution has been growing in agriculture, constantly looking for opportunities to apply the principles of sustainable agriculture, include environmentally-friendly practices and create products with high performance, such as quality, usefulness for human health and environment, authenticity and traditions. Critical issues of rural development remain unresolved, namely the extent to which agriculture is the engine of rural development, the future viability of small farms, the potential of the rural non-farm economy in the current pandemic crisis.

Despite the unfavourable characteristics and unresolved problems, rural areas have a unique natural, human, economic and cultural potential that must be developed and fully exploited. Harizanova points out that by adapting policies and in particular measures for rural development in Bulgaria, sustainable positive development can be achieved in all sectors, and the rural area is a place for the development of agricultural activities, but it also offers good prospects for progress in the economy, through appropriate support for business, job creation and tourism development [4]. Other authors [11] point out that rural tourism in Bulgaria is a socio - economic phenomenon, providing great opportunities for municipalities. Therefore, the interconnection and interdependence between the two economic sectors is especially important to find opportunities for the development of alternative tourism with the formation of unique tourism products and the application of environmentally-friendly agricultural practices in order to achieve higher living standards and economic benefits for local communities.

The aim of the research is related to the study of the opportunities and challenges for the development of alternative tourism in rural areas through an analysis of the relationship with agriculture.

MATERIALS AND METHODS

The research methods used in the study include: basic scientific research methods, questionnaire survey, summary and synthesis, logical method, tabular and graphical presentation of characteristics and trends. The survey was conducted in the period January-March 2021, covering questions about the preferences for tourist travel in pandemic conditions and attitudes towards local food. The tasks of the research include outlining the challenges facing alternative tourism and agriculture in the context of a pandemic crisis, as well as outlining the interrelationship for their development to achieve sustainability. To achieve the formulated aim, the interconnection and interdependence of the unconditionally connected economic sectors (agriculture and tourism) is monitored and analysed in the direction of the possibility to create unique tourism products and diversify activities in rural areas in order to increase the competitiveness of the local economy.

The nomenclature of the territorial units for statistics NUTS divides the territory of Bulgaria into three levels: NUTS 1, NUTS 2 and NUTS 3, respectively 2 regions (in Bulgaria they are called statistical zones) [22], 6 planning regions and 28 districts. Planning regions or the so-called NUTS-2 statistical regions, according to the classification of territorial units for statistical purposes in Bulgaria are regions, separated for the main purpose of statistical reporting, according to the requirements of Eurostat [10]. The study focuses on the North-West Planning Region (NUTS-2), as one of the six planning regions, including the districts of Vidin, Vratsa, Lovech, Montana and Pleven. Based on statistical data on key economic indicators for the last 10 years, it was found that the city of Pleven is not only the largest in population, but also has become an economic, social and cultural centre, i.e. it can be defined as the economic core of the district and the North-West planning region. In the research it is necessary to study the opinion of the population of both those living in towns and villages. Therefore, the authors choose the empirical study to be conducted in the municipality of Pleven, which includes 2 towns and 23 villages. From the distribution of the population in Pleven municipality, it was found that that about 90% of the population lives in the towns, and in the villages there are about 10% of the population, as it is concentrated mainly in the villages: Bukovlak, Yasen, Opanets, Grivitsa, Brestovets, Koilovtsi. On this basis, the implementation of a survey by filling in a questionnaire by people living in the settlements in the municipality is justified. The survey received the support of the "Agriculture" Municipal Service – Pleven, thanks to which the questionnaire can be filled in by citizens visiting the municipal administration in Pleven, the town halls in Slavyanovo and in the villages: Bukovlak, Yasen, Opanets, Grivitsa, Brestovets, Koilovtsi.

To determine the total number of respondents or in particular the required number of questionnaires to be completed, a standard formula was used to determine the sample size, under the following conditions:

-As the variation in the totality and variance of previous surveys are not known, it is assumed that the percentage of people who would complete the survey and those who refuse to complete it is 50% each;

-The confidence coefficient is 95% or $p(z) = 0.9500$;

-Maximum permissible error of 10%.

As a result of the calculations, it was found that the number of completed questionnaires should be 984. The obtained sample is zoned by settlements, as the distribution of the number of respondents is according to the relative share of the population in them and is presented in Table 1.

Table 1. Distribution of the questionnaires by settlements

Settlement	Number of questionnaires	Relative share
the city of Pleven	842	85,6
the town of Slavyanovo	50	5,1
Bukovlak	40	4,1
Yasen	20	2,0
Opanets	10	1,0
Grivitsa	10	1,0
Brestovets	6	0,6
Koilovtsi	6	0,6
Total:	**984**	**100.0**

Source: Survey data.

Table 1 clearly shows the number of questionnaires that must be obtained within the survey in order to meet the requirements for representativeness and to use the opportunities provided by statistical evaluation methods. Random non-repeated selection is applied, and one person is given the opportunity to fill in a questionnaire.

Prior to the actual survey, a pilot survey was conducted to determine the quality of the questionnaire used and, if necessary, to adjust it. The results of the control testing of 30 randomly selected citizens, identifying themselves as potential tourists, showed that the questions are understandable, well-formulated, do not create confusion and do not make it difficult to fill in the questionnaire. The completion of questionnaire is anonymous and in order not to raise doubts about the confidentiality of the information provided and to avoid the involvement of officials assisting in the survey, there is no section with questions characterizing age, gender, social status, etc.

The survey was conducted in the period January - March 2021 through a survey of residents of the municipality of Pleven, who used public services in the municipal administration of Pleven and the mayoralties of the settlements included in the sample, and the condition to fill in the questionnaire is to identify potential tourists from the Pleven region.

After the end of the research period, all questionnaires were subjected to subsequent logical control, after which the information from them was entered into specially designed table layouts, the data were grouped and summarized. The data are processed using specialized statistical software – Microsoft Excel.

RESULTS AND DISCUSSIONS

The pandemic and challenges to alternative tourism

The pandemic and challenges to alternative tourism. Despite numerous warnings from scientists, in early 2020, politicians and societies around the world were largely unprepared for a pandemic of such scope, depth and duration. The American professor Dipesh Chakrabarty believes that Covid-19 is not just a pandemic, but a new episode in the evolutionary history of life on Earth. The rapid growth of the human population and the aggressive destruction and change of the environment create conditions for easier passage of various coronaviruses from their natural reservoirs in nature to humans. This is a long-term trend that calls into question the thesis that man is the main engine and ultimate goal of the evolution of life on our planet, especially considering that microbes have existed on Earth for 3.8 billion years, and Homo sapiens - only 300 thousand [2].

The Coronavirus inevitably changes many activities and sectors, but hardly else are these changes as visible and direct as in the tourism industry. On the one hand, significant changes have taken place in the demand for mass tourism destinations that are being avoided. However, at least in the near future, boutique, sustainable and alternative products and destinations will certainly be in greater demand, incl. outdoor activities in clean and preserved nature. In this sense, logically, domestic tourism is developing and to a greater extent the alternative types, incl. rural tourism, ecotourism, etc. The tranquillity, the beautiful nature and the good cuisine are the basic characteristics that determine Bulgaria to remain a preferred destination not only for the active seasons, but also outside them. In this regard, alternative tourism may be able to fully reveal its potential with all its diversity and tourists' preferences for its practice.

According to a study by Lulcheva for the period June 1, 2019 - February 31, 2020 in the Western Rhodopes Region (Bulgaria) after the COVID-19 pandemic, mass travel is unlikely to be as popular, although it will be relatively cheaper. Tourists will seek more individualization and consumer interest to focus on a better quality tourism product, ensuring greater security and safety [6]. Other authors also argue that the impact of the global health crisis, both at European level and indirectly in other countries, necessitates the identification of strengths in the current crisis, mainly through the location of tourist reception structures in rural areas, some of which are isolated, which offer high health protection [23].

The advantages of our country for the development of alternative types of tourism are indisputable, as each of these alternatives can "coexist" with the others in a unique and characteristic way. And this is an opportunity for unique tourist products and satisfaction from positive experiences. From the Strategy for sustainable development of tourism in the Republic of Bulgaria with Horizon 2030, it is described that rural tourism is practiced by 21.7% of Bulgarian tourists in summer (in second place after the sea tourism) and 30.2% outside the active summer and winter seasons, when it is most popular among Bulgarian tourists [8]. According to Ivanova, "The symbiosis agriculture − tourism has many

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expectations…" related to the contribution to sustainable development [5].

In this regard, we aim to examine the relationship between the two economic sectors based on the unconditional role of agriculture in creating a unique and specific tourism product and through diversification of activities in rural areas in the development of rural and agritourism.

Interconnection based on the creation of unique and specific tourist products

The set of tourist services offered and/or provided in one or more tourist sites is referred to as a "tourist product" [1]. The tourist product "rural and agricultural tourism" includes the creation of service packages, reservation systems and monitoring aimed at specific target groups. In this regard, a number of authors consider accommodation and meals as "basic tourist services", and the term "additional tourist services" includes all other activities. The meals, together with the accommodation and the transport, are the main elements in the structure of the tourist product. The main interconnection and interdependence between the two economic sectors derives from here. Food products are a natural necessity for sustaining the life of the human body. Therefore, it is important for each person to be able to meet their needs, depending on their individual diet. There are more and more people who prefer Bulgarian products on their table [13]. Food as a product of agricultural production and an opportunity for added value from agricultural activities is an important component in the structure of the agritourism product. In this regard, in recent years the production of quality food products has become a cause for innovative entrepreneurs in the agricultural sector, as well as an important need for modern consumers of guaranteed certified organic foods, incl. in the field of tourism. It is not only a vital biological need, but also a component that leads to an increase in the positive difference depending on the cultural traditions of the region and the preferences of tourists. According to the Association of Ecotourism in Romania 80% of the purchased products (food, organic farm products, souvenirs and other goods) are mainly produced by the locals and/or are typical local products, the certified products from the region are considered/consist of commercial products of good value - organic products (at least 80% of the product) [16]. For most tourists, local dishes are the healthiest and home-cooked meals in rural areas are the most delicious. Garden vegetables from own farm, home-made skim milk, marmalade, etc. are highly valued. And when, in addition, the food is served to the guests with a story about its origin, it arouses great interest and satisfaction. One of the main requirements in Bulgaria for the target groups of tourists who visit certain destinations is the authenticity and quality of the products in their food. Moreover, now in the conditions of pandemic crisis and the development of mainly domestic tourism, the attention is shifting from large complexes to smaller, secluded guest houses and family hotels with preserved nature. For the period January - March 2021, through a survey of potential tourists from the Pleven region, we studied the attitudes to travel during the Easter holidays (Fig. 1).

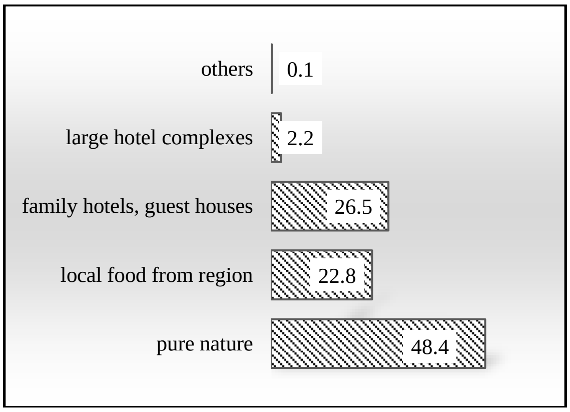

Fig.1. Attitudes and preferences of potential tourists to visit during the Easter holidays, 2021 – relative share.
Source: Own calculation based on data from the questionnaires.

The presented Figure 1 shows that a large part of the respondents prefers travelling to destinations with pure nature and family hotels or guest houses. Here the interrelation between the mentioned sectors is further emphasized and is expressed in the preferences for food from own farm or food from the respective region – (e.g. organic products). Recently, there has been a growing interest in producers and producer groups of

Protected Designation of Origin (PDO), Protected Geographical Indication (PGI) and Traditional Specialities Guaranteed (TSG). Local producers of these foods not only enhance the image of their products, but also provide access to new markets, incl. tourist. For instance - PGI Gornooryahovski sudzuk, TSG Fillet Elena, TSG Pastrami beef, TSG Kayserovan vrat Trakiya, TSG Role Trapezitsa, TSG Lukanka Panagyurska, PDO Strandzhanski manov med/Manov med ot Strandzha. This year, registration is expected to be approved for PGI "Lutenitsa Parvomay" / "Parvomayska Lutenitsa", PDO "Bulgarian White Brine Cheese" and PDO "Bulgarian Yogurt" in the European Register of Protected Designations of Origin and Protected Geographical Indications [9]. It has been proven that traditional Bulgarian dishes with a specific character are an attractive means to visit, not only by foreigners but also by Bulgarian tourists. They are an image and trademark of the specific region or cuisine and become an important factor for holiday satisfaction in Bulgaria.

Proven their advantage in a number of European countries with experience in rural and agricultural tourism, and now in our country, the development of a country house and a farm is considered as a winning formula for creating an attractive product. The hostess offers traditional hand-made dishes, and the farm is most often a plant-breeding farm (e.g. white brine cheese and curd cheese are made by hand) and the owners have a certificate for direct sale. They sell not only to the tourists, but also to regular customers from the region and in restaurants (Fig. 2).

Direct farm sales are an opportunity to design unique tourist products. They can be successfully realised by including them in the agritourism product (products that are not available in large hypermarkets).

In this regard, of particular importance in our country is the publication of the Regulation on direct deliveries from small farms [21], which allows small farms to look for good alternatives for offering their products and their inclusion in tourist offers.

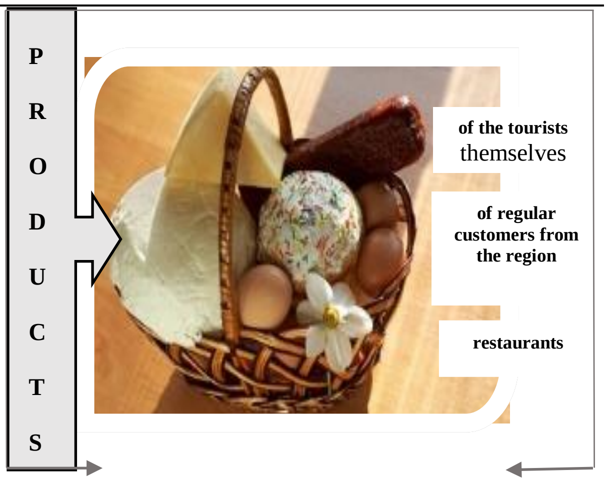

Fig. 2. Opportunities for own product realization
Source: Author's figure.

For instance, a list of operators registered under Ordinance № 26 on the specific requirements for direct deliveries of small quantities of raw materials and food of animal origin is available on the website of the Ministry of Agriculture, Food and Forestry in the subsection "Bulgarian production" [9]. And not only this, often when visiting tourists prefer to buy a specific local product (Fig. 3).

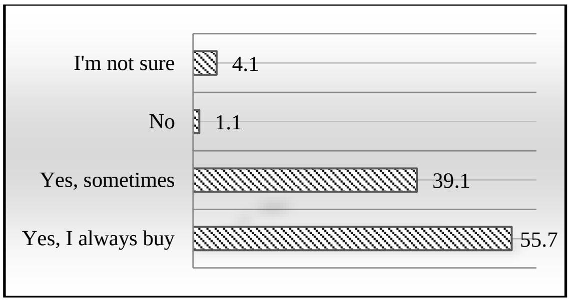

Fig. 3. Assessment of preferences for purchasing local food products, %
Source: Own calculation based on data from the questionnaires.

When asked "*Would you buy a local product*", the opinions of the affirmative respondents are the most common. At the very least, there are preferences for not buying a local product or answering "I am not sure". In recent years, many tourist sites (hotels, restaurants, family hotels, guest houses) offer in their menu food that is entirely prepared with organic products – from their own farm or direct deliveries from the area. Consumer expectations are associated with increased interest in such sites. In order to determine whether the place of residence influences the propensity to purchase locally produced products, the correlation coefficients of association, contingent and colligation were calculated, the groups "town" and "village" were formed for the factor "place of residence" and for the "buying a local product" - the groups are "yes" and "no". The results of the study of this dependence are as follows: the coefficient of association is 0.9856, the coefficient of contingency is 0.6688, the coefficient of colligation is 0.8428. The coefficients are statistically significant and show the presence of a strong, even very strong correlation between the place of residence and the tendency to buy local products. The population in the cities has a much stronger desire to buy local products, which shows that the demand for healthy and quality products of Bulgarian origin is becoming an increasingly conscious need for the modern urban consumer.

To the question *"Do you think that the supply of organic products in the restaurant and hotel chain is enough?"*, 89.36% of respondents answered negatively (Fig. 4). This undoubtedly confirms the orientation of the modern consumer in the direction – clean and healthy food, food of local origin and , high-quality indicators.

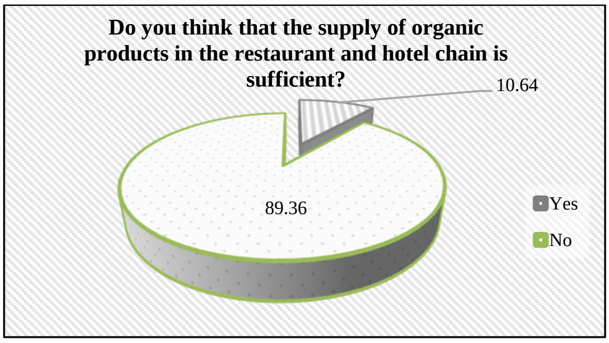

Fig. 4. Relative share of the used organic products in the restaurant and hotel chain (%)
Source: Own calculation based on data from the questionnaires

The dependence between the place of residence and the opinions of the consumers for sufficient supply of organic products in the restaurant and hotel network was also studied. The results of the analysis show that there is a strong relationship between them, as the following correlation coefficients are obtained: the coefficient of association is 0.9746, the coefficient of contingency is 0.5573, the coefficient of colligation is 0.7963. The population in the cities almost categorically expresses the opinion that the supply of organic products in the restaurant and hotel network is not enough, which means that there are unused reserves in terms of both supply and consumption of organic products of local regional nature. The goal of modern farms is to introduce innovative management approaches. The planned diversification of the activity, independently related or unrelated to agricultural production, is aimed at processing and sale of agricultural products. And the motivation of the farmers is for continuous improvement and generation of added value from the production, which is reflected in the realisation not only through the main service of the tourists – food, but also through the direct sales.

From researched destinations of Central Balkan regions – Veliko Tarnovo (Emen, Elena, Zlataritsa, Mindya, Mihalci); Gabrovo (Dryanovo, Sevlievo, Tryavna); Lovech (Apriltsi, Oreshak, Troyan) and Western Rhodopes (Devin, Trigrad, Borino, Shiroka Laka, Yagodino) on the basis of surveys the assessment of the possibilities for forming an agritourism product in Bulgaria has been made [14]. The main findings of the authors show that the approaches to solving problems are most often sought not in internal change and restructuring (optimisation of product strategy, expansion of activities by including non-agricultural profitable activities, including rural and agricultural tourism), but in support of the state and state institutions. The responsibility for business success is transferred to the insufficient or untimely financing of agriculture by the state, without looking for reserves within the business unit itself and the possibilities of one's own initiative. We can summarize that nutrition, in addition to being a natural necessity for the human body, is a highly valued component of the tourist product and an important factor for full tourist satisfaction. The possibilities of this interconnection can become a tool that has a significant impact on the development of local economies.

Interrelation based on the diversification of activities in rural areas through the development of rural and agricultural tourism

The diversification of activities in rural areas, through the development of tourism, for some regions has a significant impact on employment and income of the population, quality of life and increasing the competitiveness of the Bulgarian economy. In these areas non-traditional tourism other than mass tourism can be developed. At the current stage, in rural areas, the following types of alternative tourism are developing most dynamically: rural, agricultural and ecotourism. They have a specific impact on local development, in particular on socio-economic development, employment and the income of the population in typical rural areas. This type of tourism enables farmers to expand their activities by increasing the value of their products and increasing their capital.

A number of holiday farms have been set up in Austria, France, Germany and England. They are a combination of agriculture and tourism, which reach their peak load at the same time of year (for holiday farms, the season is until July or August). In a number of Bulgarian regions where agriculture is not the main source of income (e.g. mountainous areas), tourism is becoming the main source of income. These places specialize in providing accommodation and food to tourists. The popularity of this form of rural tourism in many European countries, and already in our country, leads to the emergence of a large network of specialized tourist material and technical basis and includes typical rural houses with a variety of entertainment services. Despite the lost direct connection with agriculture, it plays an important role in the economy at the local level and is considered one of its most important forms. A typical example is the Wild Farm in the Eastern Rhodope Mountains - a secluded hereditary house at the entrance of the Gorno Pole village, which is not the generally accepted "guest house", but an open home for all friends, seeking freedom, the call of the wild and the colour of life. The owners produce organic products and extract bio-honey, prepare delicious Eastern Rhodope specialties, raise in a natural way several hundred cattle of the local breed Rhodope shorthorn cattle and Bulgarian gray cattle - an old protected Bulgarian breed. The farm has certificates for the veal, honey and vegetables, as well as for the pastures where the animals graze. There are many adventures on offer: horse riding, boating, picnics in the forest, searching for honey from wild bees, catching a wild cow with a lasso, watching vultures, a tour for minerals and extraction of gold nuggets [25].

Farm tourism, also called the residence in a rural region, for the purpose of recreation and getting to know or practicing certain elements of the activity of the agricultural holding with which the offered tourist service is closely connected. The services can include almost all forms typical of rural tourism, but they are more closely related to agriculture: rural guest houses, a farm for horses and equestrian sports, an inn, an old farm, etc. A characteristic feature of agrarian tourism, as a more specialized tourist activity, is the offering of a specific tourist product. In countries where rural and agrarian tourism have a long history (France, Belgium, etc.), agrarian tourism has "melted" in favor of purely tourist specialization, leaning towards rural (even mass) tourism. For countries such as France, Italy, Spain, Belgium, England, Austria, rural tourism is highly developed and is already an established business. In some countries such as Austria, southern Germany and others, agrarian tourism predominates, including in high mountain areas [7]. Despite the stronger trends for the development of rural tourism, in a number of countries not only rural but also agricultural tourism is increasingly developing. The motivation for its accelerated development in developed countries can be sought mainly in two directions:

-lack of highly economically developed agricultural sector;

-increased interest in the use of fresh and healthy food.

For Bulgaria, at this stage, there is a stronger interest in rural tourism. In the coming years, the expectations for the development of tourism in rural areas are aimed at combining the different alternative types in order to obtain higher incomes. Great hopes are placed on the development of rural and agricultural tourism, as a prerequisite for the revival of the Bulgarian countryside and for sustainable development of rural areas.

Despite the great rise in the development of rural tourism in the last few years, it should not be seen as a tool that will by itself solve the complex socio-economic problems of sustainable rural development. The readjustment in the direction of increasing the share of the persons using the services of the rural and agricultural tourist product, as well as the economic interest in this type of business is connected, among other things, with a change in the value system of people. And this is a long and difficult process, requiring a period of over 10 years. In order to support the further development of this part of the tourism industry, it is necessary to activate at the local level the various organisations, associations and others in solving specific local and regional problems. It is they who can contribute to the restoration and development of sites and manifestations of local rural culture: old houses, monasteries, historic sites, traditional holidays, etc., to seek various sources of financial support in order to strengthen the local and regional economy.

Rural tourism has a significant contribution to the rural economy and has untapped potential for contribution to regional economic growth. Among the reasons why alternative tourism is considered a promising factor for regional economic growth is that sometimes in regions where conditions are unfavourable for the development of other economic activity (agriculture) there are a number of favourable prerequisites for its development. Thus, especially in rural areas that have undergone economic restructuring with a declining role in agriculture, hopes are placed on the development of the tourism sector as a key factor for economic development and income opportunities for the rural population.

Bulgaria is considered a little-known, safe and stable tourist place located near Western Europe. At the same time, its establishment as a destination for alternative tourism – ecological, cultural, rural – in a separate or combined tourist product is a condition for sustainable economic and social development in environmentally friendly practices [15]. Therefore, the diversification of activities in rural areas through the development of rural and agricultural tourism plays an important role in the economy at local level, as the motivation for its accelerated development in certain territories is related to the impossibility of a highly economically developed agricultural sector, interest in the use of fresh and healthy food and clean nature.

CONCLUSIONS

The performed analysis gives us reason to formulate the following more important conclusions, namely:

First. The pandemic inevitably affects the economic sectors, and to a greater extent it is a negative impact on the tourism business. Logically, domestic tourism, and in particular alternative tourism, is more represented.

Second. Food is an important part in the construction of unique and specific tourism products in rural areas, as the relationship agriculture – tourism is strongly emphasized in terms of requirements for clean and healthy food, incl. organic products or the purchase of local products from the region. Research on potential tourists shows high preferences for it, as one of the main services in tourist sites – guest houses, family hotels. In this way, the development of alternative tourism in rural areas contributes to sustainable development on a regional scale, while providing employment, income and improving the quality of life of local communities.

Third. The diversification of activities in rural areas through the development of tourism is an opportunity to develop entrepreneurial initiatives and stimulate the production of food and local crafts, especially in areas where agriculture is not the main source of income. The strong connection and interdependence between the economic subjects in the indicated economic branches of key importance is fully manifested in the successful combination of the interests of all concerned participants in the process of development of the specific territory/region.

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PROFITABILITY AND HINDRANCE OF GOAT PRODUCTION AMONG RURAL HOUSEHOLDS IN NIGERIA: PERSPECTIVES OF NIGER DELTA AREA

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Abstract

The specific objective was to evaluate goat farming profitability. The 240 samples were drawn using structured technique. Data were evaluated using descriptive statistics and profitability model analysis (cost and returns analysis). A moderate family size of 10 persons and average age of 48 years educational level were dominant. Most farmers were well-experienced with low flock size of 12 goats averagely. Extensive management system were adopted and most respondents engaged in cassava production in addition to goat farming. The average revenue derived from goat farming was ₦384,000 ($929.78) with total cost of farming of ₦299,990 ($734.02). The benefit-cost-ratio of 1.3 was achieved revealing 30% profitability. Lack of credits were most hindrance of farmers. The study recommended farmers credit provision for increase in goat production.

Key words: *goat, production, profitability, rural-household*

INTRODUCTION

The earliest or oldest species domesticated were goats mostly used for slain, hair, milk and meat in most areas globally [2]. Also [6] reported that goat are known primarily for meat, milk, hairs and dungs serves as fuel. Goat play a pivot role of providing rural households with employment, food security, income reducing unexpected risk in farming thereby providing socio-economic empowerment [13]. Goat has varied water consumption pattern, kidding is short, housing demand is shorter, high level of multiple births and hardiness to environmental shock that makes it fit into rural sector for economy boost [7].

The major problem of Nigeria growing population is lack of protein intake [12]. The fundamental problem encountered in Nigeria is inadequate protein intake resulting to malnutrition probably due to poverty ravaging the country [1]. Stated that one of the problems that is prevalent in Nigeria resulting to malnutrition is declining protein intake mostly from food and animal sources. Among sources of supplier of protein in Nigeria, goat feature predominantly accounting for approximately 34.5 million, cattle are 13.9 million and sheep are 22.1 million [8]. Goat meat is a good source of animal protein in Nigeria as mostly consumed by all without religious taboo. This study concentrated on goat profitability as literatures revealed that less work have been done in this area.

MATERIALS AND METHODS

The objectives of the research work were to determine the socio-economic characteristics of goat farmers, examine goat production management systems, examine farming enterprise of goat farmers, determine goat farmers mean annual revenue, evaluate goat farmers mean annual cost of production, analyse profitability of goat production and; examine goat farmers' hindrances

The survey put into focus the Niger Delta area in representation of the entire Nigeria goat production. The area is composed of nine local government areas that mostly engaged in Agricultural production for their livelihood. The area is blessed with crude oil which is the -essential mineral resources of Nigeria that earn the country her foreign exchange. It has an overall population of 5,198,605 persons

[9]. Most crops grown in the area were cassava, maize and yam in addition to fisheries and livestock production [4].

The sampling procedure adopted was multi-stage in chosen randomly 240 goat farmers. Firstly, five states were chosen randomly from the nine existed states. Secondly, four local government areas (LGAs) each were chosen randomly given a total of 20 LGAS. Thirdly, four rural communities each were chosen randomly amounting to 80 rural communities and lastly, three goat farmers each were chosen randomly giving a total of 240 respondents.

Data were gotten with assistance of structured questionnaires administered to goat farmers. Data were analysed with the aid of descriptive statistics and cost return analysis

Model Specifications

Descriptive statistics

$$\text{Mean } (\bar{X}) = \frac{\Sigma fx}{F} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Profitability Model Analysis (Cost and returns analysis):

$$TCg = TVCg + TFCg \ldots\ldots\ldots\ldots\ldots\ldots(2)$$

$$GMg = TRg - TVCg \ldots\ldots\ldots\ldots\ldots\ldots(3)$$

$$NRg = GMg - TFCg \ldots\ldots\ldots\ldots\ldots\ldots(4)$$

$$BCRg = TRg/TCg \ldots\ldots\ldots\ldots\ldots\ldots(5)$$

where:
Σ = Summation sign
f = Frequency
x = Class mark
TRg = Total revenue from goat production
TCg = Total cost of goat production
TVCg = Total variable cost of goat production
TFCg = Total fixed cost of goat production
GMg = Gross margin of goat production
NRg = Net returns of goat production
BCR = Benefit Cost ratio of goat production.

RESULTS AND DISCUSSIONS

Socio-economics characteristics of goat farmers. The parameters in Table 1 stipulated household size of 10 persons averagely with a mean age of 48 years that were mostly married engaging in goat production. Most respondents were well experienced in goat farming having 20 years of farming experience with low educational qualification of primary school (42.9%) that were mostly carried out by female gender. The goat size were relatively low having a mean size of flock of 12 goats and most farmers engaged on goat farming on part-time basis.

Table 1. Socio-economic characteristics of Goat Farmers (n = 240)

Socio-economic characteristics	Frequency	Percentage (%)	Mean/ Mode
Age in years			
26 – 35	32	13.3	
36 – 45	61	25.4	
46 – 55	78	32.5	48 years
56 – 65	69	28.8	
Gender			
Male	87	36.3	Female
Female	153	63.7	
Family Size (persons)			
3 – 5	28	11.7	
6 – 8	53	22.1	
9 – 11	71	29.6	
12 – 14	65	27.1	10
15 – 17	23	9.5	persons
Farming Status			
Part-time	231	96.2	Part-
Full-time	9	3.8	time
Marital Level			
Married	114	47.5	
Single	24	10.0	
Widow	53	22.1	Married
Divorced	49	20.4	
Educational status			
Primary school	103	42.9	Primary school
Secondary school	91	37.9	
Tertiary school	46	19.2	
Farming Experience (years)			
1 – 11	47	19.6	
12 – 22	94	39.2	20 years
23 – 33	74	30.8	
34 – 44	25	10.4	
Flock size (number)			
1 – 7	77	32.1	
8 – 14	95	39.6	12 goats
15 – 21	52	21.7	
22 – 28	16	6.6	

Source: Field Survey data.

These reports were similar with the assertion of [3] that most livestock farmers were with low educational qualification that were mostly aged with moderate family size of 9 persons engaging in livestock farming on part-time basis.

Goat production management system. Most respondents as indicated in Table 2 practice semi-intensive system of management (58.3%) while others practice intensive system (36.3%) and extensive system (5.4%) which was the least practiced. This report was confirmed by [11] that three management systems namely extensive, semi-intensive and intensive systems existed in Nigeria and most commonly used was semi-intensive system.

Table 2. Goat production management systems

Management system	Frequency	Percentage	Mode
Semi-intensive system	140	58.3	Semi-intensive
Intensive system	87	36.3	
Extensive system	13	5.4	

Source: Field Survey data.

Farming enterprises of goat farmers. The variables in Table 3 revealed that farming enterprises engaged by goat farmers were fisheries (8.2%), cassava (17.4%), yam (15.5%), maize (14.4%), vegetables (9.4%), goat (7.3%), sheep (7.4%), cattle (0.8%), pig (6.6%) and poultry (13.0%) production. Most respondents engaged in cassava production since cassava product (garri) is a stable food for most Nigerian.

Table 3. Farming enterprises of Goat farmers

Variable	Frequency	Percentage	Mode
Fisheries	108	8.2	Cassava Production
Cassava	229	17.4	
Yam	203	15.5	
Maize	189	14.4	
Vegetables	123	9.4	
Goat	96	7.3	
Sheep	97	7.4	
Cattle	11	0.8	
Pig	86	6.6	
Poultry	170	13.0	

Source: Field data. Multiple responses observed.

Goat farmers mean annual revenue (Naira). The parameter in Table 4 showed that mean production capacity were 12 goats which indicated low production capacity of goat production. The mean rate per goat was ₦32,000 amounting to ₦384,000 ($929.78) mean revenue per animal.

Table 4. Goat farmers mean annual revenue (Naira)

Variable	Mean	Amount (₦)
Quantity (Goat)	12	
Rate per goat (Naira)	32,000	
Total Revenue (Naira)		384,000

Source: Field Survey data.

Goat farmers mean annual cost of production. The information in Table 5 shown that expenditure were in purchase of young goats (kids), feeds, medication/disinfectants, labour and transportation which made up the total variable cost of ₦285,000 while loan interest, tools depreciation and rent on land made up the total fixed cost (₦5,990) incurred in goat production. The total expenditure (cost) incurred was ₦299,990 ($734.02). It was observed that most expenditure were in purchase of young goats (₦168,000) and feeds (₦90,000). [5] agreed with the research in his work in Ekiti State, where total revenue for goat farming was huge and encouraging.

Table 5. Goat farmers mean annual cost of production

	Rate (₦)	Amount (₦)
Variable Cost (12 goats)		
Purchase of young goats (12 kids)	14,000	168,000
Feeds (60 bags)	1,500	90,000
Medication/Disinfectants		16,000
Labour		8,000
Transportation		3,000
Total Variable Cost (TVCg)		**285,000**
Fixed Cost		
Interest on loan		1,490
Depreciation on tools		2,100
Land rent		2,400
Total fixed cost (TFCg)		**5,990**
Total Cost (TCg)		**290,990**

Source: Computed from field data.

Profitability of goat production. The information in Table 6 stipulates that the total revenue and total cost of goat production was ₦384,000 ($929.78) and ₦290,990 ($734.02) respectively. The goat production gross margin and net returns was ₦99,000 and ₦93,010 respectively. These figures reveals that goat production was profitable business. The business benefit-cost-ratio was 1.3 which clearly indicates 30% profitability, also shown that 30k will be made for every one naira committed into the business, this also indicates business profit. This implies that goat farming is a good source of additional income to rural households. This assertion is supported by [14] that goat farming contributed substantially to rural farmers' income in Jammu and Kashmir, India.

Table 6. Profitability of goat production

	Amount (₦)
Total Revenue (TRg)	384,000
Total Variable Cost (TVCg)	285,000
Total Fixed Cost (TFCg)	5,990
Total Cost (TCg)	290,990
Gross Margin (GMg) = TRg – TVCg	99,000
Net Returns (NRg) = GMg – TFCg	93,010
Benefit-Cost-Ratio = TRg/TCg	1.3

Source: Computed from field data.

Goat farmers' hindrances. The parameters in Table 7 showed that farmers' hindrances were lack of fund (20.0%), price fluctuation (14.9%), and high cost of feeds (17.6%), grass unavailability (19.8%), theft (9.1%) and lack of extension agents (18.6%). Most goat farmers experienced lack of fund and grass unavailability to feed the animals especially in the dry season as a major hindrances. This assertion was confirmed with [10] that major challenges of goat production were finance, price fluctuation, market seasonality, theft and expensive medication in Oyo State.

Table 7. Goat farmers Hindrances

Parameter	Frequency	Percentage
Lack of fund	231	20.0
Price fluctuation	172	14.9
High cost of feeds	203	17.6
Grass unavailability	229	19.8
Theft	105	9.1
Lack of extension agents	214	18.6

Source: Field data. Multiple responses observed.

CONCLUSIONS

The study revealed moderate family size of 10 persons and a mean age of 48 years that were mostly married engaging in goat farming. Most respondents were with low educational level of primary school that were experienced in goat farming engaging on part-time basis. The sizes of flock were relatively low which were mostly carried out by females. Extensive system of goat management were mostly adopted. Most respondents engaged in cassava production in addition to goat production. The average revenue derived from goat farming was ₦384,000 ($929.78) with total cost of production of ₦299,990 ($734.02). The benefit-cost-ratio of goat production was 1.3 revealing 30% profitability. Most goat farmers' hindrance was lack of fund and animal grass unavailability. The study recommended provision of credits to goat farmers to increase their flocks for higher productivity.

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SOME CONSIDERATIONS REGARDING MEAT CONSUMPTION IN ROMANIA (2014-2018)

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Abstract

Meat is an essential food used by the population to meet food needs, it is an important source of protein and fat. Meat consumption is highly variable worldwide, at least due to the preponderance of certain species in its establishment. The structure of consumption is linked to the customs and traditions of each region. For this reason, the purpose of the paper was to analyze meat consumption in Romania in the period 2014-2018 pointing out its dynamics, structure and annual change. At national level, there is a preponderance - in consumption - of pork, followed by poultry (about 87% of total consumption at national level). It can be seen that the total level of meat consumption was 65.78 kg, a level which was constituted by actual contributions of: 0.58 kg - other types of meat, 2.26 kg - sheep and goat meat, 5.62 kg - beef, 23.80 kg - poultry and 33.52 kg - pork. The consumption of edible organs was 3.10 kg (4.71% of the total consumption). There is a need to improve the structure of total meat consumption by increasing the share of beef and other meats.

Key words**:** *meat, consumption, evolution, structure, variation*

INTRODUCTION

Meat, as an agricultural product, is obtained from adult, semi-adult and young animals [1]. Consumer meat demand results from a combination of economic, political, technical and other socio-cultural factors [4].
The consumption of meat is undoubtedly linked to the production obtained and trade with this product. In Romania, the variation of meat production can be observed (27.38% - beef, 9.70% - poultry, 6.19% - pork, 4.25% - sheep and goat meat) [6]. Meat production is influenced by many factors, most notably technological factors [10]. The Romanian meat market is dependent on the imports made, which influences to a significant extent the consumption [14].
Meat consumption is mainly influenced by the type of food and the price level [3]. In this context, it can be shown that the level of meat consumption is also influenced by the health care of the consumer [12]. It can be mentioned that the young consumer segment is willing to pay a higher price if it is correlated with a higher quality of the purchased product [2]. The evolution of meat consumption is variable, so it is found that in the EU it had declining trends between 2008 and 2014 [13]. For Romania, there can be an uneven evolution of consumption between 1990 and 2010 [9]. Meat consumption is also linked to the traditions associated with a particular territory or region. Thus, for Romania, pork is a traditional product preferred by most of the population [11]. In terms of consumption expenditure, meat is the main product purchased [8].

MATERIALS AND METHODS

The paper was written based on the levels of the indicator - meat consumption (kg/ inhabitant), an indicator that was highlighted based on accessing two specialized databases [5, 7]. Meat consumption is presented in general, but also for the main species: pigs, cattle, sheep and goats, birds, other meat. At the same time, organ consumption is mentioned.
Documentation was followed by data processing.
The comparison method was used. In addition to the time sequences included in the analysis

(2014-2018), we also operated with their average. Also, structural indices were determined (annually) and the absolute variation of the indicators from one year to another was established.

The structure indices were determined according to the formula:

$$IS_C = \frac{C1, C2, C3, \ldots\ldots Cn}{CT} x100\ (\%), \text{în care:}$$

- IS_C – structure index (%);
- C1, C2, …..Cn = meat consumption by type (kg);
- CT = total consumption (kg).

The relationship was used to calculate the absolute variation of consumption:

$\Delta C = C_n - C_{n-1}$ (±kg),

where:

- ΔC – consumption variation (kg);
- C_n – meat consumption of the year n (kg);
- C_{n-1} – meat consumption from the previous year (kg).

The analysis was carried out both at national level, but the comparison was also made - in space with the existing situations at world, European and Community level (EU).

RESULTS AND DISCUSSIONS

Table 1 shows the structure of the average annual meat consumption per capita, for the period 2014 - 2018.

Table 1. The structure of annual meat consumption per capita in Romania (kg)

No.	Specification	Year									
		2014		2015		2016		2017		2018	
		Effective*	Str. %**	Effective*	Str. %**	Effective*	Str. %**	Effective*	Str. %**	Effective*	Str. %**
1	Meat and meat products	57.80	100	63.40	100	65.50	100	68.40	100	73.80	100
2	Beef	5.60	9.70	6.30	9.94	6.10	9.32	4.90	7.17	5.20	7.04
3	Pork	29.00	50.18	31.30	49.36	32.90	50.23	36.10	52.78	38.30	51.90
4	Goat sheep meat	2.30	3.98	2.20	3.47	2.30	3.51	2.30	3.36	2.20	2.98
5	Bird meat	20.10	34.75	23.00	36.28	24.10	36.79	24.90	36.40	26.90	36.45
6	Other types of meat	0.80	1.39	0.60	0.95	0.10	0.15	0.20	0.29	1.20	1.63
7	from which: edible organs	3.10	5.28	3.30	5.21	3.10	4.73	3.10	4.53	2.90	3.93

Source: *http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table, Accessed on 15.03.2021 [7].
** own calculations.

If we refer to the specific situation of 2014, there is a total consumption of 57.80 kg, constituted by percentage contributions as follows: 50.18% pork (29.0 kg), 34.75% poultry (20.10 kg), 9.70% beef (5.60 kg), 3.98% sheep and goat meat (2.30 kg) and 1.39% other meat (0.80 kg). Edible organs accounted for 5.28% of annual consumption (3.10 kg).

In 2015, the total level of the indicator was 63.40 kg, of which at the product level the contribution was as follows: 0.60 kg other meat (0.95%), 2.20 kg sheep and goat meat (3.47%), 6.30 kg meat beef (9.94%), 23.0 kg of poultry (36.28%) and 31.30 kg of pork (49.36%). For edible organs a level of 3.30 kg was registered (5.21% of the total consumption).

At the level of 2016, there is a discussion of variable levels of meat consumption from 0.10 kg in the case of other types of meat up to 32.90 kg for pork (extreme weights of 0.15 and 50.23%), and the general situation of the indicator showed a share of 65.50 kg. Poultry meat with 24.10 kg (36.97%), beef with 6.10 kg (9.32%) and sheep and goat meat with 2.30 kg (3.51%) also contributed to the total consumption. The share of edible organs, in total, was 4.73% (3.10 kg).

If we refer to the specific situation of 2017, there is a national situation characterized by a total consumption of 68.40 kg, consisting of percentage contributions as follows: 52.78% pork (36.10 kg), 36.40% poultry (24.90 kg), 7.17% beef (4.90 kg), 3.36% sheep and goat meat (2.30 kg) and 0.29% other meat (0.20 kg). The situation of consumption of edible organs is reflected by a weight of 4.53% in the general level of the indicator (3.10 kg).

In 2018 the indicator recorded a general level of 73.80 kg, of which for each type of meat the contribution was as follows: 1.20 kg other types of meat (1.63%), 2.20 kg sheep and goat meat (2.98%), 5.20 kg beef (7.04%), 26.90 kg poultry (36.45%) and 38.30 kg pork (51.90%). For edible organs there was a level of 2.90 kg (3.93% of the national total).

Figure 1 shows the situation of meat consumption at national level for the period 2014-2018.

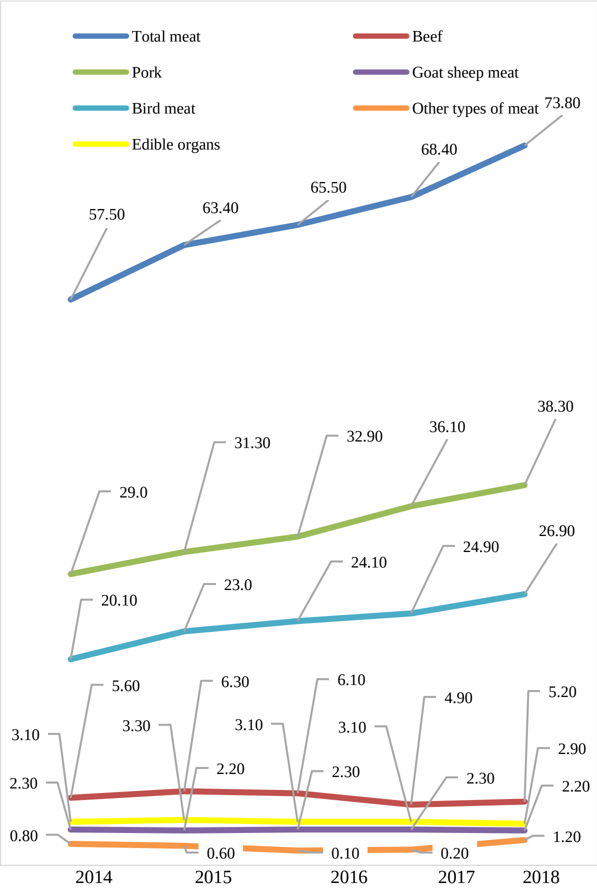

Fig. 1. Meat - average annual consumption per capita (kg)
Source: Own design and calculation.

Table 2 presents the situation of the absolute variation of the annual meat consumption per inhabitant.

At the level of beef, there is a fluctuation in consumption, the lowest negative differences being 0.20 kg in 2016 compared to 2016, and the most pronounced reached 2.10 kg for 2017 compared to 2016. There are also increases in 2015 compared to 2014 - 0.70 kg and in the case of 2018 compared to 2017 - 0.30 kg.

In the case of pork, it is found that the indicator showed only growth trends: +2.30, +1.60, +3.90 and +2.20 kg for 2015, 2016, 2017 and 2018 respectively.

Consumption for sheep and goat meat is characterized by the existence of a situation when the indicator increases, compared to the terms of reference, respectively the year 2016 (+0.10 kg), an equitable situation (2017) and by two situations of decreasing the level of the indicator - years 2015 and 2018 (-0.10 kg each).

Table 2. Absolute variation of annual meat consumption per capita in Romania (kg)*

No.	Specification	±Δ 2015 vs. 2014	±Δ 2016 vs. 2015	±Δ 2017 vs. 2016	±Δ 2018 vs. 2017
1	Meat and meat products	+5.60	+2.10	+2.90	+5.40
2	Beef	+0.70	-0.20	-2.10	+0.30
3	Pork	+2.30	+1.60	+3.90	+2.20
4	Goat sheep meat	-0.10	+0.10	-	-0.10
5	Bird meat	+2.90	+1.10	+0.80	+2.00
6	Other types of meat	-0.20	-0.50	+0.10	+1.00
7	from which: edible organs	+0.20	-0.20	-	-0.20

Source: * own calculations.

For total consumption there are increases in 2015, 2016, 2017 and 2018 respectively compared to previous years, as follows: +5.60, +2.10, +2.90 and +5.40 kg respectively (Fig. 2).

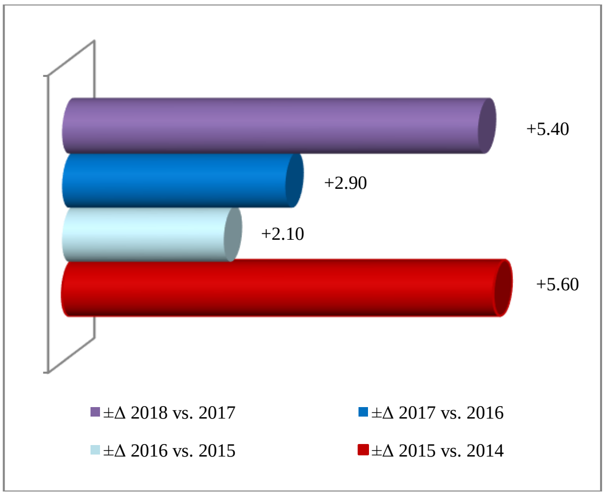

Fig. 2. Total meat consumption per capita - the absolute variation (±kg)
Source: Own design and calculation.

Consumption of poultry meat is characterized, strictly, by successive annual increases of the indicator: +2.90, +1.10, +0.80 and +2.0 kg - in the years 2015, 2016, 2017 and 2018 respectively.

For other types of meat, there are two situations of decrease in 2015 and 2016 (-0.20 and -0.50 kg), as well as two situations of increase in 2017 and 2018 (+0.10 and +1.0 kg).

In the case of organ consumption, there are decreasing trends of the indicator level in 2016 and 2018 (-0.20 kg each), a stationary trend in the case of 2017 as well as an upward trend in 2015 (+0.20 kg).

Table 3 shows the situation of total meat consumption and its structure, by types of meat as an average of the analysed period (2014-2018).

Table 3. Annual meat consumption per capita in Romania - average of the period (kg)

No.	Specification	Effective*	Str. %**
1	Meat and meat products	65.78	100
2	Beef	5.62	8.54
3	Pork	33.52	50.96
4	Goat sheep meat	2.26	3.44
5	Poultry meat	23.80	36.18
6	Other types of meat	0.58	0.88
7	from which: edible organs	3.10	4.71

Source: * own calculations

It can be seen that the total level of meat consumption was 65.78 kg, a level which was constituted by actual contributions of: 0.58 kg - other types of meat, 2.26 kg - sheep and goat meat, 5.62 kg - beef, 23.80 kg - poultry and 33.52 kg - pork (Fig. 3). The consumption of edible organs was 3.10 kg (4.71% of the total consumption).

The percentage structure of the indicator was as follows: 50.96% pork; 36.18% poultry meat; 8.54% beef; 3.44% sheep and goat meat; 0.88% other types of meat (Fig. 4).

Compared to the world, European and Community situation (European Union), Romania ranks as follows (Table 4): below all three reference levels for beef (negative differences of 37.49, 59.01 and 60.45%); above the world level (2.18 times ahead), but below the continental and community levels (-1.38 and -13.36% respectively), in the case of pork; superior to all reference levels in sheep meat and goat meat (exceedances by 15.90, 26.26 and 13.57% respectively); above world and Community levels (1.55 and 1.03 times respectively), but below the continental level (-1.57%), for poultry; below all three reference levels for beef (-24.68, -67.96 and -62.82% - Fig. 5).

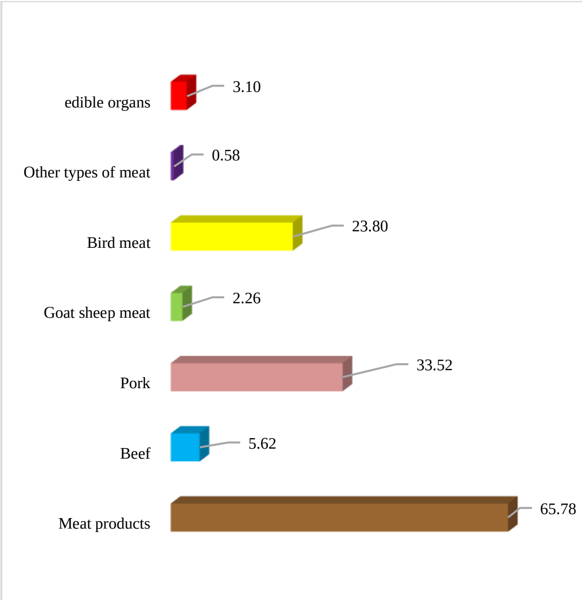

Fig. 3. Meat consumption per capita - the average of the period (kg)
Source: Own design and calculation.

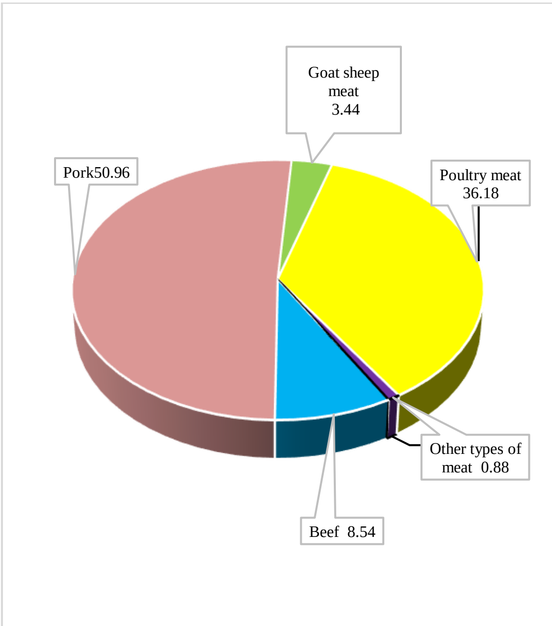

Fig. 4. Meat consumption per capita - average period, structure (%)
Source: Own design and calculation.

Table 4. Annual meat consumption per capita - Romania's position in the international context - average of the period (kg)*

No.	Specification	World level	European level	U.E. level	Positioning in relation to the situation (%):		
					Global	European	U. E.
1	Beef	8.99	13.71	14.21	62.51	40.99	39.55
2	Pork	15.35	33.99	38.69	218.37	98.62	86.64
3	Goat sheep meat	1.95	1.79	1.99	115.90	126.26	113.57
4	Bird meat	15.29	24.18	23.06	155.66	98.43	103.21
5	Other types of meat	0.77	1.81	1.56	75.32	32.04	37.18

Source: * own calculations.

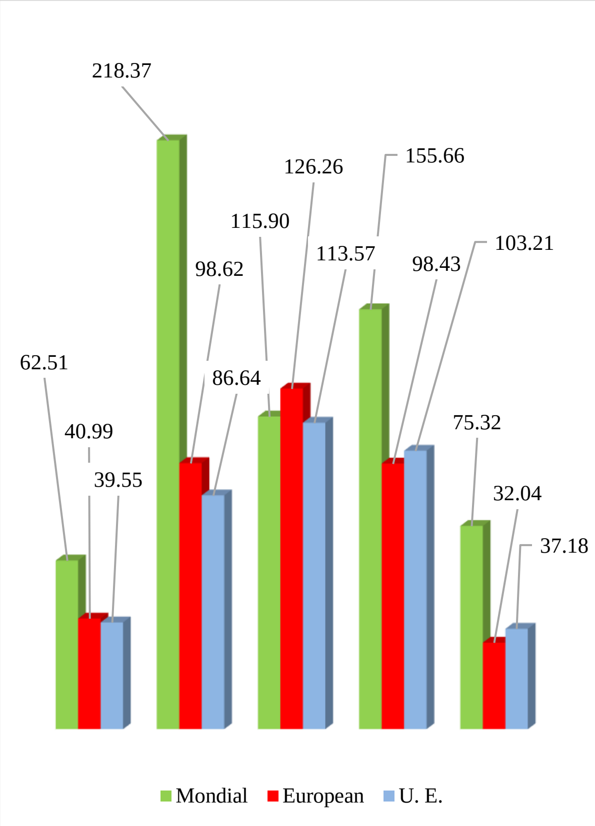

Fig. 5. Romania's positioning, at international level, in terms of annual meat consumption (%)
Source: Own design and calculation.

CONCLUSIONS

Romania must pay special attention to the livestock sector, which must be the main supplier of raw materials for the food industry, which can contribute to increasing the surplus value resulting from meat processing and reducing the national balance of payments deficit, to the products concerned.

Appropriate subsidization of raw material suppliers and processors can be achieved through appropriate government support measures as well as access to European funds.

At the same time, there is a need to improve the structure of total meat consumption by increasing the share of beef and other meats.

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FEATURES IN REGIONAL DEVELOPMENT AND TOURIST POTENTIAL OF THE MOUNTAIN REGIONS AND AREAS IN BULGARIA

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Abstract

The focus on mountain areas within the European Union in recent years has become an essential part of the common regional policy, which is aimed at making spatial development a top priority of the European institutions. In the present exhibition an analysis is made of the tourist potential of the mountain municipalities in Bulgaria, which develop tourism. The territorial peculiarities of these regions are presented, their peculiarities and specifics in the context of their regional development are considered. The opportunities for them to improve their tourism potential and, above all, to create a new environment for implementing regional development policies are also outlined. The relevant conclusions and recommendations for achieving a sustainable tourist framework of the mountainous regions in Bulgaria have been made.

Key words*: mountain, development, geourbanism, regional policy, modeling. area*

INTRODUCTION

In Bulgaria, regional development and tourism since the mid-1980s have emerged as priority areas for promoting local socio-economic development. However, this process is not only for Bulgaria, similar policies towards mountain regions are pursued throughout Europe. The volume of the accommodation base of tourism in Bulgaria has been growing very fast since the mid-60s of the last century - from 302 thousand beds in 1969, 420 thousand in 1972 and 490 thousand in 1981 to 572 thousand beds in 1986 according to our national statistics. This predetermines the focus of our research on mountain regions. In Bulgaria, after the changes in the 1990s and the withdrawal of government to pursue targeted policies in mountainous regions over the past 20 years, they have been identified as problematic areas. The opportunities for their withdrawal development go through the creation of economic alternatives. In the Bulgarian conditions in recent years there has been a loss of significant demographic potential in the mountainous regions. For example, in Smolyan district the population as of 1992 was 154,554, and in 2019 it amounted to 105,421 inhabitants according to data from the National Statistical Institute. This shows that for almost 30 years in one of the mountainous areas the population has decreased by almost 1/3, the picture is similar in the districts of Gabrovo, Lovech, Vratsa, as well as in the mountainous areas of the other districts in the country. In this respect, a significant reason is the lagging behind in the level of economic development and tourist development in our mountainous parts. Over the last 30 years, regional development in these regions has been relatively low compared to other European mountain regions. In our conditions, the main deficit is related to the deteriorated infrastructure and transport accessibility to a number of tourist sites. This deficit has been overcome in most European countries. In addition, we can assume that a large part of the territory of Bulgaria is characterized by low saturation/ density of the total tourist potential. The high density of anthropogenic tourist sites is naturally established in settlements with a concentration of architectural monuments and well-preserved Revival architecture (Plovdiv, Koprivshtitsa, Veliko Tarnovo, Nessebar and others) or where there is a large number of archaeological sites (Plovdiv, Veliki Preslav, Kaspichan, Nessebar, Kazanlak and others). In general, the model of regional development does not create sufficiently reliable mechanisms for the development of regional business, and hence the tourism potential of the regions. The model of development of the Black Sea resorts has been chosen, and the development of the mountainous areas for entertainment and tourist purposes is quite lagging behind in comparison with Bansko, Borovets and Pamporovo. There are 143 resorts in Bulgaria, of which 54 are balneotherapy, 55 are climatic mountain resorts and 34 are climatic sea resorts. The capacity and healing potential of some of them are the reason for granting them the status of national importance [9]. In the years of transition there was a reduction in the total capacity of the accommodation base (up to 136 thousand beds in 2000), but at the same time in recent years there has been a change in the type of tourists by actually reducing the number of beds in chalets, student camps, private homes and campsites at the expense of hotel complexes and specialized guest houses.

In the period between 2001 and 2016 the number of beds (in hotels, campsites and other places for short-term accommodation - tourist and holiday villages, chalets, private rooms and apartments, holiday resorts, holiday bungalows, guest houses, etc.) increased - from 129 thousand in 2001 to 328 thousand in 2016. In the last 5 years, construction in tourism has also made some progress [8]. A bad sign for the development of tourism was the crisis with COVID-19, which became a test for people, businesses and government institutions. The solutions in this direction are related to the good coordination and the joint efforts are a necessary condition for understanding the nature of the problem and the search for adequate solutions. In the new conditions, regional development and tourism are still without an alternative and basis for the economic development of the world. In practice, the tourism industry provides a livelihood for millions of people in both developing and developed economies. The crisis has put about 150 million tourism jobs at risk globally. Small businesses (which account for 85% of world tourism) are particularly vulnerable. Women, who make up nearly 60% of the tourism workforce, young people and workers in the informal economy are among the most at risk. Problems facing regional development and tourism have intensified since 2020. Referring to the National Statistical Institute [9] for the visits of foreigners to the country, in 2020 a serious decline in the travel of foreign citizens was registered, due to the suspension of international flights and the closure of land borders. The annual rate of decline in visits by foreigners to Bulgaria in April amounted to -88.9% (by 650.3 thousand fewer visits), and in total for 2020 the decrease amounted to -60.4% (by 7,578.7 thousand more). few visits). On this basis, new challenges to regional development are brought to the fore, and hence to the functioning of the tourism business. The search for solutions in the direction of reassessment of operational models and long-term business model of development of mountain areas. This means that regional development must modernize mountain regions. This means complete electronization on the territory of Bulgaria. It is necessary to create a widespread use of online payments, the introduction of best practices for the management of the tourist base. Also forecasting future travel trends, tourist preferences, and pricing models to maintain profitability. In this way we will try to bring out those features of the regional development that can contribute to the development of the local tourist potential in the mountainous regions of Bulgaria [13].

MATERIALS AND METHODS

The focus of our exhibition will be on the opportunities for development of mountain tourism. It attracts a large number of visitors who have an impact on the local economy. This provides opportunities for strengthening local economic activity in the direction of transport, tourist base, food, souvenir production and more. The object of this type of regional policy are about 30% of the area of Bulgaria, which is occupied by mountains. Here it is necessary to present the main picture of the tourist flow in Bulgaria. It shows that the longest stay of foreigners in the areas specializing in sea holiday tourism - longer in the Burgas region (average 6.7 nights per person) and slightly shorter in the Varna region (5.8 nights). For Bulgarians the values are 3.8 and 3.0 nights respectively. In the areas where the ski resorts are positioned, the average length of stay is a little over 3 nights for foreigners and about 2 - for Bulgarians. A place for a longer stay for foreigners is the region of the Valley of Roses (4.0 nights). For Bulgarians the stay in all other areas is very short - 1-2 nights [20]. We can assume that tourism has its niche, especially if we deduce the data for 2019, as can be seen from Table 1, that the total number of tourist visits of foreigners in Bulgaria is 9,311,681, before the entry of Covid-19.

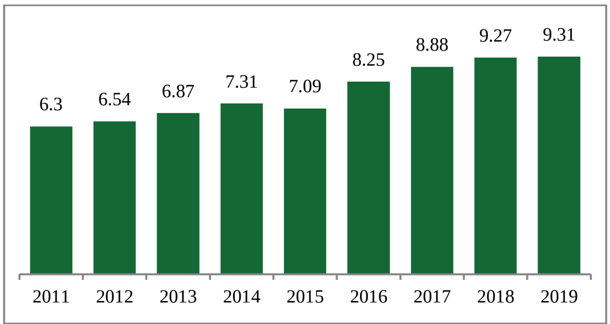

Fig. 1. Tourist visits of foreigners in Bulgaria (millions)
Source: National Institute of Statistics, NIS, 2021 [9].

In this direction, provided that investments are made in the tourism industry and, above all, we see real improvements in the regional development of Bulgaria in the period 2022-2027, we can reach these levels again. Moreover, the country has the potential to develop the industry and annually welcome about 14-15 million tourists. The analysis of revenues from the period before Kovid-19 shows a positive trend. Thus, revenues from international tourism for Bulgaria amount to over 3.7 billion euros in 2018. The growth compared to 2017 is 6.5%. In 2018, Bulgarian tourism continued to develop in an upward direction, building on the excellent results of the previous two years - the peak for the sector in 2016, which achieved records in all parameters, and 2017, which was remembered with a boom in international travel due to the peak of low-cost airlines.

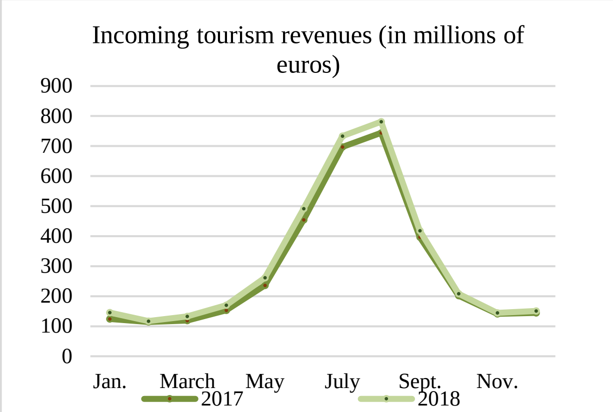

Fig. 2. Revenues from international Tourism (Euro million) - monthly and annual data
Source: Bulgarian National Bank, 2021 [1].

According to experts, 2019 is slightly weaker than in 2018, but the crisis of 2020 had an extremely negative impact on the tourism industry. While 2020 was particularly difficult for the tourism industry, in 2021 the picture is at least somewhat more favorable. The change came both in the form of various government support schemes for business and relief in travel requirements in Europe. Based on expert assessment by experts in tourism and data announced by the Institute for Market Economy, 2021 is more favorable for the tourism industry. In the three summer months (June, July and August) of 2021, the total number of overnight stays in the country reached 11.3 million - a significant improvement from 6.3 million in 2020, but still far from 16.4 million for 2019 As expected, most of them - about 5.3 million overnight stays - were in the Burgas region, where sea tourism is concentrated. The district has almost doubled the number of overnight stays compared to last year, but their number remains almost three million less than in pre-crisis 2019. The dynamics is similar in Varna, where overnight stays reach 2.6 million, compared to 4 million before the crisis, and in Dobrich - 985 thousand compared to 1.7 million [11]. From the presented picture it is evident that sea tourism prevails again. This gives us reason to focus our attention on tourism in mountainous and semi-mountainous areas. It is obvious that in these territories there are great reserves to achieve attractive socio-economic development by creating a sustainable regional economy based on tourism and related industries. The spatial planning of mountain areas, this can be seen as an activity and good coordination, but perhaps the specificities of mountain areas and how they are affected by specific sectoral policies need to be brought to the fore. They, in turn, have the corresponding added value for diversification and increasing the number of activities of small and medium-sized enterprises., as well as for cooperation between them [6]. In each part of the mountainous areas we observe a specific development of agriculture and forestry. In order to improve regional development in our conditions in this direction, the Pan-European regional policy has its territorial dimensions, which also includes visions for a targeted impact on mountain areas. The focus of regional development must impose policies for economic and social development of mountain areas, equating them with the pursuit of conservation of natural resources, local traditions and culture, in the direction of their effective management and opportunities for spatial planning. However, few countries have a more comprehensive, integrated mountain policy and specific instruments such as mountain laws or mountain funds (France, Italy, with some conditionality - Switzerland). Public interventions to promote the development of mountain areas vary significantly not only depending on the importance and diversity of these areas, but also on the institutional structure of each country (centralized, federal, old and new EU member states, acceding countries, etc.). A particularly important policy instrument, which is often a prerequisite for the implementation of other instruments, is the definition of mountain areas. The criteria for determining mountain areas are different, but always include altitude - although with different values in different countries, most often depending on their latitude - Italy, France and to some extent Switzerland). It is important to note that the institutional structure of the state has a significant impact on the policies pursued to promote the development of mountain regions. Of course, what is important is the socio-economic situation of the country, what experience it has and what is its access to European Union funds. Additionally, their diversity and features that require a specific approach to them. This predetermines the imposition of specific investment instruments through which the implementation of policies for the development of mountain regions is required. Criteria for defining mountain regions have been introduced in individual countries, for example in France, Italy and Slovakia they define 600 meters depending on their latitude. Other countries such as Greece consider 800 meters to be suitable for a mountainous area, and in Spain, Switzerland mountainous areas are areas with 1,000 meters above sea level. In some countries, additional criteria are introduced, such as relative height in Italy, and in countries such as France, Slovenia and Spain, the slope of the mountains is also influenced. According to the global criteria in connection with global warming, the need for the explicit framework of ski resorts and a mandatory requirement for their functioning has been introduced. For example, in countries such as Slovakia, tourist zoning is an essential element of tourism policy for these specific regions and territories. In this respect, we have the best developed zoning system in Switzerland, where 4 (four) types of tourist areas are formed (mountain areas, lake areas, urban areas and other areas). The focus on Bulgaria shows that agreement can be sought on setting the priorities of mountain tourism and its segmentation. A common weakness of the Bulgarian tourism policy is the attempt to orient itself initially with ski tourism. In modern development, mountainous areas have the opportunity to develop different types of tourism, which are essential for the development of settlements in the mountains. To a large extent, mountain tourism can be enriched and develop the diversification of a tourist product. This means looking for opportunities for year-round work of mountain areas with tourists, which means the development of different types of tourist products. There are large reserves in the rational use of the spring and summer seasons, as well as partly the autumn [12]. In practice, in mountainous areas it is necessary to pursue a targeted territorial policy, both in housing and the formation of functional areas that combine settlements, entertainment, nature and transport accessibility, so as to protect our environment. This is related to the formation of the Bulgarian mountains on large areas of NATURA 2000, which have a special model of nature management. They provide various opportunities for recreation, entertainment and sports. Tourism in the mountains can be practiced both in winter and in summer. The duration of the ski season is about 130 days, and the rest of the year has its charm for tourism. From the point of view of transport accessibility, the largest mountains are best secured, as well as those with a central location in the country. In this respect, the Rhodopes and the Balkan Mountains stand out. Due to its central location in the Central Balkan Mountains and the Middle Fore-Balkans are some of the most visited tourist sites by Bulgarian tourists. Important roads pass along Rila and Pirin, as well as some mountains in the region. The border mountains are in the most unfavorable position [11]. Undoubtedly, the tourist potential of Bulgaria is great, but in geo-economics terms there are deficits in the implementation of a number of regional policies to encourage its development. In this regard, the factors for the development of mountain tourism in Bulgaria can be divided into general (with global impact) and local (with regional or local impact). In addition, the factors can be considered as selective, localization and implementation in terms of ongoing regional development policies. This determines the focus on the development of mountain tourism to fall on the municipalities in the mountainous areas [20]. What has been said so far implies that the use of statistical information, the reference to expert assessment and analysis of published public information by state and local authorities will give us the necessary methodological justification and opportunity for accurate assessment of ongoing processes. To a large extent, the comparative analysis, spatial approach and statistical information capture the trends in regional development and how it affects tourism development. In addition, the tourism industry itself needs additional focus not only on creating infrastructure and improving accessibility, but also on quality service of the tourist flow [11].

RESULTS AND DISCUSSIONS

In our time, mountain regions are focusing more and more on investment projects. In practice, however, mountain areas need to be known and brought to the forefront of pan-European spatial development policy. It is necessary to point out that the planning of financial and program instruments for the development of mountain areas is becoming an increasingly important part of European regional policy. The set policy should be based on the modernization of the mountainous areas, as well as to create conditions for the preservation of the local culture and tradition. An important aspect in the development of mountain areas is to improve the accessibility to them and the possibility to create local productions and promote tourist destinations [4]. However, few countries have a more comprehensive, integrated mountain policy and specific instruments such as mountain laws or mountain funds (France, Italy, with some conditionality - Switzerland) In most European countries, a targeted policy for the development of mountain areas has been pursued since the late 1970s. The solution of local problems is not identical, because the mountainous areas are diverse and have different problems and the need to implement targeted regional development policies. Another significant problem is their institutional nature, due to the specifics of regional and local government, which results from the unitary or federal nature of the countries in Europe. In this direction, the definition of a mountainous area is discourse, which requires different impact instruments to be applied in different regions. In Bulgaria, the mountain and semi-mountain municipalities in the country are 123 and occupy 42.5% of the country's territory, with 2,555 settlements, in which 20.9% of the country's population is concentrated [12]. These parameters rank our country 7th in terms of the share of mountain areas among the EU member states. When applying the European methodology for Bulgaria, the similar indicators are higher (over 50% for the territory and the population), as this category of municipalities includes regional centers such as Smolyan, Gabrovo, Kardzhali and even the capital municipality, which meet the above. criteria6. The choice of one or another criteria and indicators for determining these areas depends on the number of municipalities and settlements that will be subject to targeted regional policy by the state. Depending on the objectives of the individual normative documents and studies, the criteria adopted in them are different and according to them the number of mountain and semi-mountain municipalities in Bulgaria varies from 120 to 144, and in their settlements - between 2,170 and 2,900. This is the framework determined by the criteria of the draft law on mountain areas of 1995, which defines 142 municipalities with 2,996 settlements in these regions. In 2003 Ordinance № 14 /01.04.2003 for determination of settlements in rural and mountainous areas was published areas issued by the Ministry of Agriculture and Forestry and the Ministry of Regional ddevelopment and public works (SG, issue 35 of 16.04.2003), which identifies 138 rural municipalities with 2,172 settlements in them.

Important for determining the range of mountainous areas is their altitude. This creates an important prerequisite to define the mountain areas depending on the latitude, climatic features and the level of accessibility. We can recall that, for example, for countries such as Italy, Slovakia and France, the mountainous area is over 600 meters, and for countries such as Spain and Switzerland it is 1,000 meters. In both cases, the leading criteria is the height and slope of the territory, but somewhere the available tourist site or resort are sufficient grounds to define the area as mountainous. The case is similar with the region of Aragon in Spain, as well as in Slovakia, Switzerland, Austria and others. We can summarize that the winning model is successful when we have successful zoning. The different typologies for defining an area as mountainous require either at least 50% of their population to live in areas defined by morphometric indicators as mountainous, or more than 50% of the area of the respective territorial unit to be mountainous [5].

When focusing on the mountainous areas in Bulgaria, it is evident that they include a little over 70% of the forest reserves, but large massifs of forests remain outside them. This creates conditions for the development of forestry and the construction of small and medium enterprises related to wood and its processing. About 1/4 of the forest fund is forests with special purpose - water protection, anti-erosion, reclamation, recreational, green systems, etc. (protected forests and territories). Almost all protected natural areas (national parks, nature parks, protected natural and historical sites, reserves, etc.) are located in the mountains. It is important to note that a little over 85% of the meadow area is also included in the NATURA 2000 boundaries, and a little over 70% are suitable for pastures. The plant diversity also has impressive characteristics [13]. In our mountains are about 2/3 of the common species of plants and plant communities in the country, many of which are of great economic importance. It is important to note the extremely important ecological function of natural vegetation (woody, herbaceous and shrubby), which is traditionally used as a source of various resources - wood, fodder, food, fruits, herbs, raw materials (production of essential oils, resins, dyes and others), mainly due to the fact that a number of plant species are also honey-bearing (about 600), or have decorative qualities (over 1,000). The mountainous regions are the main generator of the country's water resources, as they contain over 2/3 of the main water sources. Numerous mountain rivers, hundreds of alpine lakes (especially in Rila and Pirin), built over 700 reservoirs in the lower belts of all mountains, as well as numerous and attractive waterfalls determine not only the tourist attractiveness of our mountains, but also their significant hydropower potential. An important place in the natural resource potential is also occupied by the mineral waters, connected mainly with the fault zones in the mountainous areas [6]. Here are a total of 70% of all mineral water deposits in the country. This natural potential of the mountains is traditionally used in a number of balneological centers, established not only with national but also with international importance such as: Hissarya, Pavel Banya, Narechen, Sandanski. Unlike other resources, mineral waters have renewable reserves and, if properly exploited, are virtually inexhaustible. There are various minerals in the mountainous and semi-mountainous territories of the country. Fuel and energy resources are represented by brown and lignite. From the ore minerals there are discovered deposits of gold, silver and lead-zinc ores and the extraction is carried out in the municipalities of Lucky, Pirdop, Zlatitsa, Chelopech, Madan, Rudozem, Krumovgrad and others. The extraction of various non-metallic minerals is much more widely represented [20]. Bentonite, quartz, perlite, talc, magnesite, fluorite, marble and limestone are mined. Nearly 1/3 of the agricultural fund and 24.6% of the arable land are located in mountainous areas [9]. The cultural and historical heritage in the Bulgarian mountain municipalities is also a kind of resource potential for development. It is based on the presence of authentic archaeological and architectural monuments from antiquity, the Middle Ages and the Renaissance, unique natural landmarks, as well as preserved over the centuries folk art and craft [7]. In terms of geo-economic development, mountain regions in Europe have their exceptional potential not only for tourism, but also for the development of specific industries and the generation of environmentally friendly life. In the mountainous regions it is possible to create a model of regional development with an emphasis on the ecological, cultural and socio-economic specifics of the individual territories. In this respect, even before the creation of the European Union, the Alpine countries in Europe pursued targeted policies regulated to support mountain regions in view of their geographical and climatic features and the way of life of the local population. Thus, the mountainous areas need quality and effective spatial planning, which will bring to the fore the specific features of connectivity, infrastructural order and creation of socio-economic environment, which will impose the model of optimal development of settlements in accordance with their demographic profile. This means that priority should be given to small and medium-sized enterprises that are linked to the local labor market and economic viability. In this respect, state measures must contribute to diversification and the possibility of imposing alternative opportunities for regional development of agriculture and forestry. Finding solutions for the development of animal husbandry, fish farming and poultry farming is one of the alternatives for local economic development [9]. These needs of mountain areas require at national level, and why not at European Union level, to develop specific operational programs for these areas. It should be borne in mind that mountainous areas will generate resources and added value from local productions and maximally compliant with the ecological environment. This will increase the range of tourism policy by developing more types of tourism in accordance with the imposed economic brands and brands. In addition, through the leverage effect of the programs, the preservation of the architectural and historical environment of the mountain as an engine of growth of the Bulgarian mountain areas will be encouraged. [10] In geo-economic terms, the development of the services sector through tax relief of half the profit tax, as well as modernization of public electronic services for citizens and companies in mountainous areas. To a large extent, attempts have been made to build mountain agricultural campuses or farms in which to promote organic farming and animal husbandry, while respecting the sustainable protection of soil, water and air [20].

Settlement and urbanization structure of the mountain regions in Bulgaria

Our mountainous areas are characterized by small settlements. A significant part of them consists of scattered neighborhoods. Their localization is very large in the Rhodopes (in the municipalities: Madan, Rudozem, Velingrad, Chernoochene, etc.) and Stara Planina (Tryavna, Troyan, Svoge, etc.). In the mountain and semi-mountain municipalities the 4th and 5th functional type prevails, ie. they have low socio-economic and demographic potential. They are located 39.4% of the villages and 36.6% of the cities of the country [4]. Unlike other territories in the country, here the relative share of the rural population is very high - 45.6%. The high concentration of villages and rural population shows the low degree of urbanization. The share of the unused housing stock is constantly growing, as well as the reconstruction of the rural houses into villa properties. On the other hand, the preservation of relatively small municipalities makes it possible to stabilize a certain administrative and institutional capacity for the provision of public services close to people's place of residence. In the second half of the twentieth century in Bulgaria were made a series of spatial plans for mountainous areas. It is important to emphasize that in the 1950s and 1960s, several development plans were made for mountain areas. Thus, the architects L. Konstantinov (1962) and P. Grigorov (1968) developed the first development plans for Rila Mountain, and in 1975 a "Program for complex development of recreation and tourism in Northern Rila" was developed by a team led by L. Stoychev. . Later, in 1985, a comprehensive landscaping plan was made again by L. Stoychev with a medium-term horizon until 2000. For Pirin Mountain a territorial scheme was developed in 1972 by arch. P. Grigorov with a team, in 1977 eng. N. Chucheva with a team designed a park development project of Pirin National Park. At the beginning of 1991, under the leadership of engineer L. Yotsova, a team developed a project with the respective development planning of Pirin National Park. This project is of significant value because it outlines the problem areas in the Pirin Mountains and provides an opportunity to solve a number of problems for the development of tourism in the mountains. An important moment in the development policies is also the general development plan for the Vitosha Mountain made by D. Sugarev (1954), later a new development plan was made, but under the leadership of arch. K. Bisserov (1975), and in connection with the application of the city of Sofia for the Winter Olympic Capital, a team led by arch. Chipev (1987) created the latest development plan of Vitosha. [4]. For the Western Rhodopes a territorial scheme was developed in 1978 by a team led by Eng. M. Kovacheva. For Sredna Stara Planina a spatial plan was developed in 1985 by a team led by Eng. M. Mladenova and Prof. L. Dinev and spatial plans of resort and tourist localizations by teams led by arch. P. Evrev and arch. [4]. The evolution of the ecological thinking and the development of the nature protection legislation with the declaration of the national parks, and later the national and nature parks, contributed to this to a great extent. Here is the place to share that after 1990 no new spatial plans of mountainous areas have been developed. There were feasibility studies for the construction of resorts such as "Super Borovets" (complex "Samokov - Borovets – Beli Iskar"), "Syutka" and "Super Perelik", but no real construction activities were reached. It is interesting that the Syutka project was developed back in 1986 and is named after the highest peak in the Rhodopes, Golyama Syutka peak - 2,186 meters above sea level. Its implementation was to affect the development of three municipalities - Velingrad, Rakitovo and Batak. The Super Borovets project is similar, which was supposed to affect three municipalities of Samokov, Dolna Banya and Kostenets. Very ambitious is the project "Super Perelik", which is a widespread name in the investment plan of the municipality of Smolyan (complex "Perelik - Pamporovo - Mechi Chal") for development and expansion of the existing resort Pamporovo as the largest and most modern tourist ski area. The Rhodopes from 300 kilometers of slopes. In practice, there are other projects that appear over time, such as the idea of building a new large resort for BGN 100 million under Kom peak in the Balkan Mountains. The project, called

Berkovski Balkan, should include new runways, lifts, hotels, restaurants, delta and paragliding opportunities. This gave rise to expectations in Berkovitsa for a powerful boost to the region, which has otherwise been declared a spa resort of national importance. The municipality of Troyan is also developing an investment project for the transformation of Beklemeto into a modern ski center. In the following, the idea is that the existing 930 m of tracks will become 9,700 m. New projects for ski tourism are being considered in the region of Uzana (Gabrovo), the Elena region below Chumerna peak, in Osogovo (above Kyustendil) and others, but in general no large investors have been found to have a lasting interest in the development of tourism. in these parts of the Bulgarian mountains [5]. To a large extent, the emerging demographic problems, the problems with the outdated infrastructure and other local problems do not have a positive impact on future investment intentions towards the Bulgarian mountains [13]. This is especially true for transport connectivity and, above all, for the road network, as road transport is the main means of accessibility in these areas. Over 90% of the roads are of low class (third and fourth) and with deteriorated functional performance. Nearly 1/3 of the settlements do not have transport connections with the local and regional centers of a higher hierarchical type. Electricity and water supply networks need investment, although they are relatively well developed and evenly distributed. With normal maintenance and rehabilitation, they can meet the future needs of the population and business. The same applies to Internet coverage, which naturally requires improved technological performance. The severely limited sewerage network and the lack of treatment plants are increasingly becoming a factor holding back modern development [2]. It is important to take into account the geographical position of Bulgaria in the European space in terms of tourism development. It is obvious that Bulgaria does not have the opportunity to develop from 7 to no more than 11 winter resorts (Bansko, Kom, Borovets, Pamporovo, Syutka, Beklemeto, Sinite Kamani, Malyovitsa, Panichishte, Chepelare and Semkovo), which means to create opportunities and development of rural, ecological and mountain tourism, because so far the effect of ski tourism is mainly sought. In the conditions of global warming the lower limit of ski tourism is already 1,200-1,700 meters above sea level, which for the Bulgarian conditions means large investments. At the present stage, the promotion of tourism in mountainous areas in most countries is not limited to the promotion of winter tourism and ski resorts, but rather the opposite - looking for differentiation of tourist products and opportunities for use during the summer season. For example, the Bergamo Tourism Development Program - Italy, the promotion of spa and spa tourism in the mountainous regions of France. We can mention as a good practice the program for the development of tourism in France, where in the 60s and 70s of the twentieth century serious investments were made in the tourist infrastructure (As well as the "Snow Plan" program in France in the 60s and 70s of the twentieth century). These investments can be explored, but the different latitudes and altitudes make their field of application difficult in Bulgaria. On the other hand, the investments of local authorities in France are aimed at promoting local business, building tourist infrastructure and providing utilities can also be designed by Bulgarian municipalities [11]. Moreover, given the capacity of our settlements in our country, resorts with small and medium capacity must be built in order to be economically connected with the existing settlements. We can emphasize that in Bulgaria requests are made for the construction of large complexes, but they require huge investments and funds, so these intentions are gradually postponed or suspended. Thus, in Bulgaria it is necessary to build medium-sized resorts and holiday villages in order to successfully fit into the socio-economic picture of the country's development. In our country, multi-season and multifunctional resorts with small capacity should be built, tied to the existing settlements and resorts [2].

Need for a new spatial planning of mountain regions

The emerging challenges facing the mountainous regions impose the need for new spatial development plans, which will undoubtedly not only more comprehensively, but also more comprehensively address the problems of development, protection and development of these areas. This need arises from the difficult transport accessibility and the deteriorating economic environment, which is a strong limiting factor for meeting the real needs of the population**.** Access to health care and health care is one of the most serious problems of mountain villages in the country [20]. It is argued that the task of public administration is to restore the practice of programming and planning at the local and regional level. The state and the municipalities do not find an optimal variant and an appropriate mechanism for determining and developing development plans of the mountainous areas in order to create an opportunity for an effective level of public works. Attempts in this direction are related to its preparation, promotion and voting by the Bulgarian Parliament [6]. Several draft laws have been drafted, the most recent being in 1998. However, this draft normative act does not become widely available to the public. According to expert assessment, such a law is dictated by the prevailing opinion that mountainous areas have specific problems and their solution should be supported by legislation. It is assumed that the mountainous areas are in an extremely difficult situation, there are processes of depopulation and disruption of the social structure, high unemployment, economic backwardness and others. According to expert assessment, a Mountain Law will lay the foundations of a national policy aimed at revitalizing these areas and purposefully investing in them [6]. Provided that the state does not have the will for a law on the mountains, I believe that it can structure a special section in the Law on Regional Development entitled "Development and Management of Mountain Territories". In this chapter, the emphasis will be on supporting socio-economic development, as well as on the structure and protection of mountain areas. We can look for an analogy with other European laws on mountains and mountain areas, which provide relief, a number of incentives for regional development, financial programs and support from public administration in order to make them an attractive place to live, work and tourism [19]. The adoption of new legislation must be based on the development and protection of mountain areas, the construction by the state of development schemes and plans of mountain regions. At the same time, it is good to build technical infrastructure in the settlements and resort areas within the mountain municipalities [10]. To regulate the relations in the mountainous regions, a state agency can be established, which will implement the general policies for the development of the mountainous regions. The role of the public sector is to promote the development of entrepreneurship of the population through the implementation of programs and projects to promote attractive economic development. In addition, it is important to determine the perimeter of construction and protection of the surrounding country. In this direction, the creation of a quality level of public works means that the mountainous areas have a modern technical infrastructure that can meet the recreational load on the territory and is responsible for environmental protection. It is important within the mountain municipalities to develop quality municipal plans and strategies that regulate the relations between the public and private sector, as well as defining the framework of the boundaries of urban areas, agricultural areas, protected areas and those for tourism and sports [11]. This predetermines the mountain areas are called to have a specific development that will model the development so as to provide opportunities for optimal functioning of mountain municipalities for the implementation of effective nature protection. The peculiarities of the NATURA 2000 sites located within the mountain municipalities must also be observed, which must be preserved as a standard of natural balance. These are the territories with a regime of protected natural environment which occupy the core of the mountains. The special regime with regard to includes all areas above the upper limit of the forest, protected natural areas, water protection zones and forests, protection zones around the resorts and resort resources. In the rest of the mountain there should be territories of natural and forestry environment, in which recreation activities and compatible economic activities are practiced. These are forests and lands from the forest fund for economic and recreational purposes [13]. The territories for localization of a resort base are oriented towards existing mountain settlements and form resort-tourist localizations. In practice, this can be a zone of urban and resort environment called "U - zone" (territory with urbanized territories and resorts), which defines the framework of urban areas and building boundaries in settlements, as well as the modeling and development of suburban areas [12]. The problems of the local areas and resort settlements must have their integrated place in the structure of the mountainous areas with application of the principle of their alternation with free natural environment, and for them the designation "N" - zone has been introduced. In practice, mountainous areas have a specific geomorphological structure, which may require the use of different schemes and models of tourism development and framework of the location of tourist sites, the choice of scheme can be for example - transversely parallel scheme in Stara Planina, Sredna Gora, Sakar and Fore-Balkans and radial scheme in Rila Mountain, Osogovo, Pirin and Verila, network scheme (Western Rhodopes, Eastern Rhodopes, Bakadzhitsite and Strandzha). In this direction, the adoption of a model of a unified transport system, which is to be completed in its most general form, turns out to be a deficit in the development of Bulgaria. This transport system must establish the necessary connections with the resort and villa areas in order to achieve a high level of accessibility to them [12]. This is necessary for several reasons, the first is the outdated road infrastructure that needs rehabilitation, secondly due to the increased number of cars it is necessary to create new parking areas and road arteries to facilitate road traffic, thirdly it is necessary to change the linear connection with the creation of linear-radial traffic systems given the location of the resorts. Last but not least, compliance with the principle of alternating urban areas with free and green areas, as well as the creation of sustainable energy infrastructure (in addition to electricity, to include gasification of mountain areas).

Strengthening and development of the settlement network and infrastructure in the mountains

Bulgarian mountain regions, as well as European ones, face common challenges arising from the presence of unfavorable factors. They are related to remoteness, depopulation and aging of the population, limited opportunities for work and access to services, lack of connectivity. This determines the need for regional development policies to overcome these deficits [8]. First of all, a complete passportization of the settlements is needed in order to bring their strengths to the fore. Within the resort-tourist localization the resort settlements, resort zones and complexes to encourage the formation of resort-settlement formations of agglomeration type [11]. Thus, all entities related to tourism must be subject to spatial planning and, accordingly, do not have a special general development plan. The measures taken by the local authorities in Bulgaria to make general and detailed development plans of resorts and tourist areas or settlements is not enough. It is necessary to build integrated development plans, where development plans and schemes have a key role and role. Our main mountain resorts such as Pamporovo, Bansko and Borovets need a similar development approach, as well as more detailed strategies for Chepelare, Atoluka, Panichishte, Beli Brezi, Semkovo, Beli Iskar, Tryavna, Elena and Kom. Regarding the opportunities for development of mountainous areas such as Momchil Yunak, Golyam Perelik, Sv. Constantine and Helena, Pashaliitsa, Syutka, Beklemeto, Uzana, Kartala and others, in addition to selection plans, it is necessary to prepare strategic documents and programs for their development and transformation into leading mountain resorts and tourist resorts. In practice, in Bulgaria, with limited human resources and declining regional economic activity in mountainous areas, it sets the need for targeted measures to improve the development of mountain settlements. In this direction, the population can be directed to these regions in terms of the wave of immigrants to our country. By building a system of financial incentives and promoting the development of tourism and small and medium-sized enterprises in these regions, it can mitigate the deteriorating demographic and urbanization processes in the country [16]. In terms of regional development, there are large deficits and lags in the development of resorts such as Banite (Smolyan), Narechenski Bani (Asenovgrad), Beli Brezi (Ardinsko), Byala Cherkva (Plovdiv), Sapareva Banya, Berkovitsa, Yundola, Sliven Mineral Baths and others. In mountainous areas, the state needs to adopt a series of policies to stimulate local economic development and encourage the strengthening of their role as tourist centers. In the last few years there has been partial progress in new construction in existing settlements and resorts such as Beli Iskar, Govedartsi, Apriltsi, Predela, Vrata village (Plovdiv region), holiday village "Constantia", Tsigov Chark, St. Constantine (Cave) and etc., but they lack quality development of the local infrastructure and a sufficiently high level of public works. As a result of the demographic decline of mountainous areas and resorts, they are experiencing difficulties in providing quality tourist services. This should be done to optimize the development plans, which means to build effective development schemes for access and development of the material base for recreation and tourism. Thus, the tourist sites can be certified and then plans and programs for their maintenance can be prepared and as well as work can be done to increase the quality of the available human capital in the area of [18]. Moreover, the settlements and the tourist sites are not always in the same territory, which necessitates to determine the basis for a complex recreational analysis of the territory. In addition, the tourist opportunities of the respective mountain region and its capacity must be assessed. This also means determining the development scheme of the settlement in relation to the individual buildings and facilities and their connection between them. In general, the size and size of the resort and its area of gravity depend on a number of territorial, demographic, urban and economic factors. An important and significant factor is the capacity of the places of accommodation in the respective region, as well as the quality of the offered tourist services. In practice, the resort resource of the settlement is essential, in this regard, for example, the capacity of winter resorts on ski slopes, ski lifts, dining places and others, which can generally show how much a resort can be loaded [15]. In our country there are similar symptoms of congestion in the active season in the resorts of Bansko and Pamporovo in terms of congestion of the capacity of slopes and lifts, with increasing interest in winter tourism will certainly arise and other similar problems. Moreover, most of our resorts have a dissected shape of the terrain (Pamporovo and Semkovo), fewer are the resorts with a compact shape (Borovets, Beklemeto). This implies finding optimal solutions for the construction of tourist infrastructure, which also affects the cost of investment in mountainous areas [17]. In practice, in the mountain resorts we need a new and better infrastructure, which will increase access and solutions to improve the tourist potential. To improve the condition of the resorts it is necessary to improve the condition of the terrains and the level of the building stock in order to rationally maintain and be friendly. It is important to mention that seasonal tourism dominates in Bulgaria and hotels and holiday homes are rarely used all year round. This requires looking for opportunities for year-round maintenance and renovation. In some of the mountain resorts such as Yundola, Semkovo, Panagyurishte columns and Orbita.

In recent years, the opportunity has been created to purchase individual apartments in hotel buildings, family hotels, village houses and others. This trend is likely to continue and more and more people living in mountain resorts will acquire property. This in turn will increase the requirements for municipalities for a higher level of maintenance of regional infrastructure. [16]. It is important to note that in the mountainous regions it is good for low construction to prevail, and where taller buildings are built not to disturb the natural balance in the mountains by maximally sparing nature. According to the construction requirements, higher density and level of construction would worsen the resort environment and would bring it closer to the nature of the urban environment [3]. Undoubtedly, the investment intentions related to the construction in the mountainous areas must be in accordance with the ecological peculiarities of the separate territories and to spare the nature as much as possible. With the already implemented privatization in the resort complexes, new plots (RLE) are to be established for the separate hotel and holiday buildings, which should not occupy more than 50-60% of the total territory of the complexes. This will protect the need for more spacious public space for wide public use in resorts [18]. In practice, in mountainous areas and especially in urban areas, resort parks, places for active sports, entertainment, recreation and recreation areas, as well as optimal location of streets, alleys, infrastructure facilities, which actually form the architectural ensemble of urban regions in mountainous areas. The emerging trend of shrinking and reducing public space in resorts and settlements in mountainous areas must be limited. It is necessary to have effective spatial planning, which will create a sustainable mountain environment for rational and modern development of mountain areas. The modernization of mountain areas and their ecological development must become a national priority.

CONCLUSIONS

Mountain areas are important for the spatial development of our country. It is necessary to objectively assess the role and potential contribution of mountain areas to achieving the pan-European development goals. There is an awareness that these areas can become an additional generator of growth with their rich resource potential, with the possibilities to provide numerous ecosystem services, with the contribution to the fight against climate change, as well as with the preservation of biodiversity and protected areas. In Bulgaria, the attempts to form a specific attitude towards these regions are carried out mainly through sectoral policies and especially in the Operational Program for Rural Development. The regional development planning documents (Strategy and National Concept for Spatial Development) also pay attention to these areas. Unfortunately, a very small part of the planned measures and instruments for impact are being implemented and so far no visible effect of their implementation is observed. The negative processes in the development of the mountainous and semi-mountainous regions are deepening, as in more than half of the municipalities they acquire critical scales. It is necessary to target targeted public investments in mountainous areas, which together with market mechanisms to develop the traditional know-how of the regions for modern agriculture and forestry, tourism and energy, ecosystem services and preservation of cultural and natural heritage, taking into account objective constraints. and conditions for their development. The change in policies targeting mountain areas will ultimately lead to the involvement of the potential of these areas in a lasting generator of additional national income. Integrated development of resource-related and complementary economic sectors in order to increase the added value for the regions and the development of the country. Typical examples of suitable production chains are: logging - woodworking - furniture production; animal husbandry - meat and dairy production - dairy and meat products; forestry - herbal medicine, cosmetics and pharmaceuticals. Priority development of small and medium enterprises such as family businesses and traditional crafts. Family businesses have strong roots in agriculture and animal husbandry, ceramics and woodworking, rural tourism and local crafts. Introduction of a national quality standard "mountain product" with clear criteria for geographical origin and unambiguous regulation of foods that may be subject to such a standard. Also creating a favorable environment for business development in mountainous and semi-mountainous regions by establishing special measures with a guaranteed budget for beneficiaries from mountainous regions in the Rural Development Program (second pillar of the CAP) for the period 2021-2027. In general, care is needed for mountainous regions. In this regard, a comprehensive overhaul of the standards and allocation mechanisms for state transfers needs to be undertaken in order to take into account the higher costs of providing services in mountainous and semi-mountainous municipalities, especially in the most remote and hard-to-reach areas.

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THE INFLUENCE OF CLIMATIC CONDITIONS ON TOURISM IN SINAIA RESORT, PRAHOVA VALLEY, ROMANIA

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Abstract

The main purpose in carrying out this paper is to convey the way in which tourism is influenced by natural and anthropogenic factors in relation to climatic elements. Behind this paper is a careful documentation on each element presented, concrete information and close to the truth in order to create a precise picture of the relationship between climate and tourism in Sinaia. Climatic data provided by National Institute of Meteorology and Hydrology and also the statistical data provided by National Institute of Statistics were used. Following the processing of statistical data, it was found that the favorable climatic factors, characteristics for each season and the specific tourist infrastructure are elements that ensure tourist flows throughout the year. The qualitative aspects in this research were studied based on current scientific literature, official documents and observation method, and the quantitative research was carried out using statistical analysis of the processed data, graphic and cartographic method, the method of observation and interpretation. The results were presented in tables, graphs and then interpreted and analyzed. Data used in this study are part of the textbook on the desk. Being one of the most spectacular mountain areas in Romania, recognized internationally by the satisfaction of tourists who arrive in these lands, this paper aims to highlight the favorable climate conditions in relation to tourism in Sinaia considered the "pearl" of the mountain resorts in the Prahova Valley. This paper presents the capitalization of tourism potential, which highlights the number of tourists arriving in the two resorts, in the period 2009-2019. Also, the private accommodation infrastructure and the number of main accommodation units, hotels and pensions are presented in detail, the typology of hotels according to the degree of comfort and the presentation of tourism in the hot and cold period of the year. Finally, we find the conclusions that highlight the main ideas that emerged from the research.

Key words: *climate change, mountain tourism, Sinaia resort, Romania*

INTRODUCTION

The favorable conditions of the environment and of the climatic factors have influenced the inhabitation since ancient times. The Prahova Valley was one of the means of connection between the ancient Dacian and Romanian inhabitants on both sides of the Carpathians.

On the current site of Sinaia, there was a pastoral settlement being favored by the geographical position that provides a favorable environment for grazing.

Throughout the day, the inhabitants raised animals, practiced agriculture suitable for mountain areas, processed wood, from which they obtained shingles, beams, slats, wooden pots, barrels.

Much later, when Sinaia became a tourist resort, with facilities and tourist means, the interest to spend a stay in this resort increased and continue to grow proportionally.

Being situated at the foot of the Bucegi Mountains which are a branch of the Southern Carpathians, Sinaia climate is deeply influenced by the changes in the factors of climate in this area.

Tourism represents one of the most important economic sectors and the unfavorable climate conditions could strongly affect the economic and social development of the mountain communities and environment [18].

In this context, the paper aims to make a correspondence between the favorable natural elements and the tourist activity in the resort, analyzing the dynamics of the frequency and the number of tourists throughout the year, and also of tourism infrastructure during the period 2009-2019.

MATERIALS AND METHODS

For a more concrete documentation, we analyzed and interpreted climate data from Sinaia in the period 2009-2019 [9]. We also used statistical data provided by NIS regarding the tourist infrastructure.
Also, it was consulted the Planning Plan of the inter-city PATZ zonal territory Sinaia-Bușteni-Azuga-Predeal-Râșnov-Brașov (Poiana Brașov) [12], a project realized within Babeș-Bolyai University of Cluj Napoca, having as project manager professor Pompei Cocean. In addition, other information about Sinaia and its tourist potential were used from another study carried out within the University Al. I. Cuza Iasi.
For the qualitative research, there were applied the following methods: documentation based on the consultation of current literature that could be accessed and official documents, and observation method.
The quantitative research used the following research methods: analysis method and data processing, graphic and cartographic method, the method of observation and interpretation.
The data were processed and converted into tables, graphs and then interpreted and analyzed. Data used in this study are part of the textbook on the desk.

RESULTS AND DISCUSSIONS

The population in the resort of Sinaia, has undergone changes over time, so it was found that The highest value of the number of inhabitants in Sinaia was recorded in 2009, accounting for 12,525 inhabitants, following that in the rest years, this number to decrease significantly, so that in 2019 to reach only 11,037 inhabitants.
Regarding the evolution of the population, an impressive decrease can be observed in the area of Sinaia, due to the lack of young population which eventually led to a negative natural growth.
The network of roads plays an important role in the economic development of the city and is also an important factor for tourism. Therefore, the city of Sinaia also enjoys highways as well as railways. Regarding the railway transport, it can be done with domestic and international trains, which travel on the directions Bucharest-Ploiesti or Brasov [14].
The total length of the Romania railway is 8,338 km [14].
The arrangement of the relief and the visit of the numerous natural and anthropic tourist objectives, made the city of Sinaia to be of high attraction for tourists, as well as for the practice of several forms of tourism, tourism representing an important sector in the development of the local economy. Sinaia presents favorable conditions for practicing several forms of tourism like: mountain, sports tourism, cultural-historical, religious and spa [12, 13].
Natural sights are an important point in the development of tourism in Sinaia and attract millions of tourists every year.
The Bucegi Mountains are a point of tourist interest for the city of Sinaia. You can also go hiking on the Piatra Mare Massif (1,843 m), Postavaru Mountains (1,799 m). However, Sinaia remains known for its famous ski slopes, which are the main attraction for tourists.
The objectives of the natural setting, that attract tourists and the anthropic objectives belonging to the religious, historical, cultural heritage, which have a rich history, traditions are "the business card" of the city of Sinaia.
The most significant monuments with architectural and cultural-historical value are The Royal Peles Castle, The Pelisor Castle, Sinaia Casino, Sinaia Monastery, Sinaia International Conference Center, "Carmen Sylva" Cultural Center, George Enescu Memorial House (Luminiș Villa), Nicolae Iorga's House, Dimitrie Ghica Park, Museum of the Bucegi Natural Rezervation, The Royal Railway Stations, Museum of train micro-models, Sinaia Heroes Cemetery [10].
The climatic characteristics of Sinaia from the perspective of their influence on tourism.

Favorable conditions for tourism activities involve certain values of climatic elements such as cloudiness, air temperature, winds, duration of sunshine.

Sinaia resort has a low intensity in terms of air currents, this being due to the location of the city within the county. The cold season in the resort is characterized by winters with mild frosts, the average monthly temperature is -3.9°C in January, -3.1°C in February and 15.7°C in July, which favors the practice of outdoor sports. winter and the duration of the days with snow cover suitable for skiing, snowboarding, sledding is about 100-120 days/year [14].

From the point of view of the relief, the Bucegi Mountains have an important role and present "bizarre" forms (Babele, Sphinx, Mushrooms) that were shaped by the wind together with the precipitation water, giving these forms through the processes of deflation and corrosion. The effects of this process are visible everywhere in Bucegi, the rocks of the peaks Caraiman, Furnica, Guțan, Bucșoiu, Țigănești present these "faces" shaped by the wind.

The average air temperature is between -2°C in the highest part of the Bucegi Mountains and over 10°C in the lower areas, the plains where there is an amplitude of approx. 13°C [15].

In the mountainous area, respectively the highest peaks (Ciucaș, Gîrbova, Grohotișu) the average air temperature is 1-2°C, while on the Bucegi bridge the temperature drops to 0°C and towards the Omu peak the temperature can drop to - 2°C [11].

After October 1, the first frost appears and the last frost usually appears at the end of April, the average duration without frost reaches 148 days.

In Sinaia, the average number of winter days is 46.8 which represent maximum temperatures above 0°C, 154 is the number of days with frost that includes minimum temperatures below 0°C, 18 represents the number of summer days which means temperature maximum of 25°C [17].

We notice that in the cold period of the year, the values are low, the lowest temperature being registered in the Sinaia area, of -2.2°C in February, followed by the increase of temperatures up to 20.1°C in August in Sinaia. These values are the result of 10 years of measuring temperatures in Sinaia (Table 1 and Fig. 1).

Table 1. Monthly average air temperature (°C) in Sinaia (2009-2019)

Month	Sinaia
January	-4.4
February	-2.2
March	2.4
April	8.5
May	13.2
June	17.8
July	19.7
August	20.1
September	15.3
October	9.2
November	4.4
December	-1.7

Source: World Weather Online, 2021, Sinaia monthly climate averages, https://www.worldweatheronline.com/sinaia-weather-averages/brasov/ro.aspx, Accessed on September 5, 2021 [17].

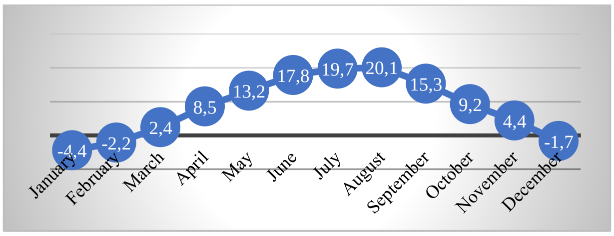

Fig. 1. The evolution of the average monthly air temperature in the period 2009-2019
Source: Own design and determination.

Table 2. Annual average air temperature (°C) in Sinaia (2009-2019)

Year	Sinaia
2009	7.58
2010	7.08
2011	6.41
2012	7.66
2013	8.16
2014	7.83
2015	7.25
2016	7.08
2017	7.25
2018	8.66
2019	10.91

Source: World Weather Online, 2021, Sinaia monthly climate averages, https://www.worldweatheronline.com/sinaia-weather-averages/brasov/ro.aspx, Accessed on September 5, 2021 [17].

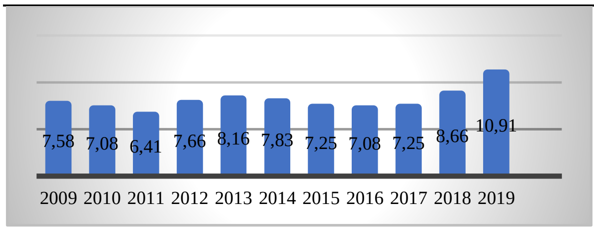

Fig. 2. Evolution of the average annual air temperature (°C) in Sinaia (2009-2019)
Source: Own determination.

Taking into account the average annual air temperature we may notice that it ranged between 6.41°C in the year 2011 and 10.91°C in the year 2019, and this reflects a trend of climate warming in Sinaia (Table 2 and Fig. 2).

The annual relative humidity has an important role in terms of tourism, it must meet a number of conditions conducive to tourism so values less than 70% indicate excellent conditions for tourism, the value of 70-80% indicates favorable conditions for tourism, 80-90% medium conditions, over 90% low conditions [3].

Table 3. Monthly average air humidity (%) in Sinaia during 2009-2019

Month	Sinaia
January	96.9
February	97
March	88.2
April	81.8
May	84.7
June	83.3
July	79.2
August	72.2
September	74.3
October	82
November	87.5
December	91.4

Source: World Weather Online, 2021, Sinaia monthly climate averages, https://www.worldweatheronline.com/sinaia-weather-averages/brasov/ro.aspx, Accessed on September 5, 2021 [17].

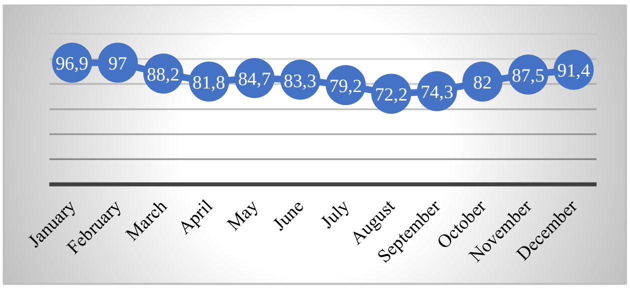

Fig. 3. Variation of the average monthly air humidity (%) in Sinaia during 2009-2019
Source: Own determination.

Table 4. Annual average air humidity (%) in Sinaia during2009-2019

Year	Sinaia
2009	91.9
2010	98.8
2011	93.9
2012	93.0
2013	92.9
2014	92.8
2015	91.4
2016	93.5
2017	91.6
2018	89.7
2019	89.0

Source: World Weather Online, 2021, Sinaia monthly climate averages, https://www.worldweatheronline.com/sinaia-weather-averages/brasov/ro.aspx, Accessed on September 5, 2021 [17].

Following the analysis of the two graphs (Fig. 3 and Fig. 4), it can be seen that Sinaia has low values of air humidity due to low altitude.

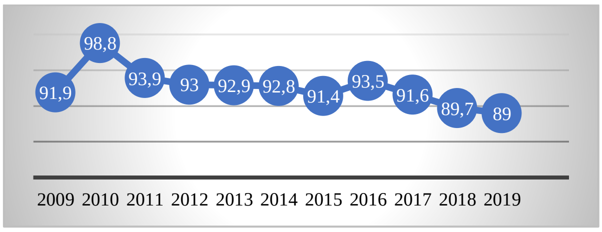

Fig. 4. Variation of the average annual air humidity (%) in Sinaia during 2009-2019
Source: Own determination.

As can be seen from (Table 3 and Table 4), The high degree of humidity in Sinaia was recorded in 2010 of 98.8%, thus preventing the practice of winter sports, which led to the appearance of fog, reducing visibility, and the lowest value was recorded in 2019 of 89.0% being average conditions for winter sports.

Nebulosity is an essential climatic parameter that determines the duration of the Sun's brightness and is defined as the degree of cloud cover. Nebulosity have an impact on all climatic elements but are influenced by the relief and the general circulation of the atmosphere [11].

It has certain limits for tourism specific to the mountain area such as the average seasonal duration with clouds with values less than 70% indicates excellent conditions for tourism, between 70-80% good favorability, 80-90% average conditions, over 90% tenth small conditions for tourism [3].

Table 5. Monthly average cloud cover (%) in Sinaia (2009-2019)

Month	Sinaia
January	54.8
February	58.1
March	48.3
April	46.4
May	43.4
June	37.1
July	30.4
August	24
September	31.4
October	38.5
November	43.3
December	48.8

Source: World Weather Online, 2021, Sinaia monthly climate averages, https://www.worldweatheronline.com/sinaia-weather-averages/brasov/ro.aspx, Accessed on September 5, 2021 [17].

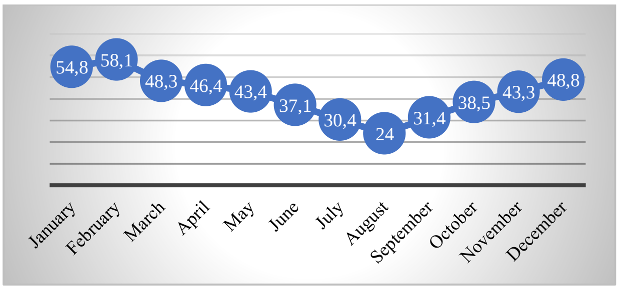

Fig. 5. Average monthly cloud cover variation (%) in Sinaia (2009-2019)
Source: Own determination.

Table 6. Annual average cloudiness (%) in Sinaia (2009-2019)

Year	Sinaia
2009	46.6
2010	54.1
2011	41.3
2012	39.9
2013	41.6
2014	47.1
2015	44.9
2016	45.4
2017	42.3
2018	46.0
2019	55.3

Source: World Weather Online, 2021, Sinaia monthly climate averages, https://www.worldweatheronline.com/sinaia-weather-averages/brasov/ro.aspx, Accessed on September 5, 2021 [17].

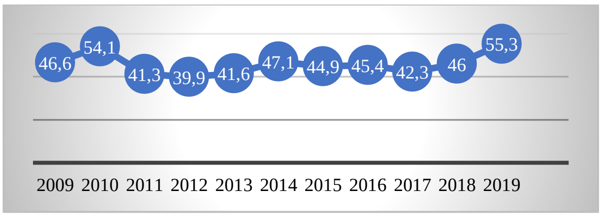

Fig. 6. Cloud cover, annual average (%) in Sinaia (2009-2019)
Source: Own determination.

Following the analysis of the graphs (from Figure 5 and figure, the mountain resort Sinaia presents low values of nebulosity, reason for which the tourist activity presents favorable conditions.

According to Table 6, the highest value of the nebula in Sinaia is 55.3% in 2019 indicating favorable conditions for tourism activities, and the lowest value being in 2012 of 39.9%.

The duration of the Sun's brightness is extremely low on high mountain peaks but also in intra-mountain depressions, this being due to the long duration of the fog and the stratiform nebula.

In the hilly and mountainous areas, the duration of the Sun's brightness is reduced from 1,900 hours and can reach values lower than 1,600 hours, where the altitudes are over 2,500m. During the warm semester, the duration of the Sun's brightness presents values between 1-800 hours in the low areas and in the high ones 1,300 hours.

Table 7. Monthly average sunshine duration (hours) in Sinaia

Month	Sinaia
January	154.7
February	143.6
March	250.0
April	303.7
May	336.2
June	353.9
July	388.2
August	393.9
September	331.1
October	210.8
November	195.8
December	182.6

Source: World Weather Online, 2021, Sinaia monthly climate averages, https://www.worldweatheronline.com/sinaia-weather-averages/brasov/ro.aspx, Accessed on September 5, 2021[17].

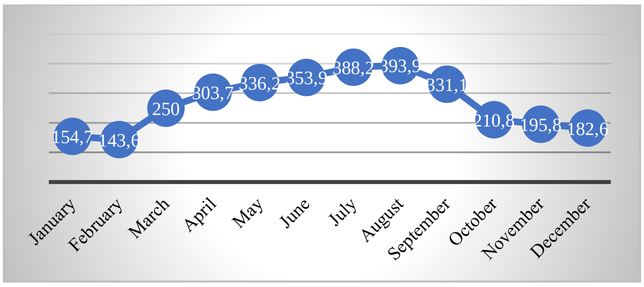

Fig 7. The variation of the average monthly duration of the sun (hours) in Sinaia
Source: Own determination.

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Table 8. Annual average duration of sunshine (hours) in Sinaia

Year	Sinaia
2009	301.95
2010	273.152
2011	310.85
2012	312.7
2013	310.3
2014	292.25
2015	294.4
2016	297.4
2017	303.25
2018	297.95
2019	257.35

Source: World Weather Online, 2021, Sinaia monthly climate averages, https://www.worldweatheronline.com/sinaia-weather-averages/brasov/ro.aspx, Accessed on September 5, 2021[17].

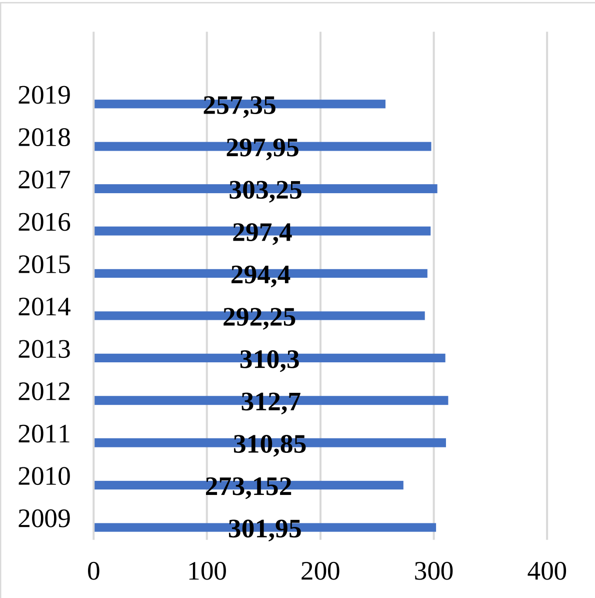

Fig. 8. Variation of the average annual duration (hours) of the Sun in Sinaia
Source: Own determination.

The duration of the Sun's brightness is strong in Sinaia (Table 8). Which favors the outdoor activities in this mountain resort, especially in August, as it appears from (Figure 8). Sinaia has high values in terms of annual and monthly average duration of sunshine. In this area, the practice of winter sports is affected by the strong sun, but this does not prevent tourists from fully enjoying the sun's rays here.

Following the analysis (Table 8) the longest duration of the Sun's brightness recorded in Sinaia during the 10 years was 312.7 hours in 2012, while the year 2019 did not enjoy a duration of brightness. of the strong sun, having only 257.35 hours.

Atmospheric precipitation depends largely on nebulosity, being a consequence of it. Being in liquid form, it has a negative impact on the development of tourism, representing a cause of psychological stress in the case of tourists.

If it manifests itself in the form of snow, it induces a state of well-being for tourists to practice winter sports (tobogganing, skiing, skating), the snow layer persisting over 64 days. The vertical area of the distribution depends on the altitude of the relief [3].

Monthly average rainfalls in Sinaia varied between 123.7 mm in the June and also in May another high level accounting for 117.8 mm and the lowest level 36.6 mm registered in September. Following the analysis of the monthly and annual average (Fig. 9 and Fig.10) of atmospheric precipitation, we deduce that the month with the most precipitation amounts for Sinaia is June.

Table 9. Monthly average rainfall (mm) in Sinaia

Month	**Sinaia**
January	48.8
February	37.9
March	49.5
April	81.6
May	117.8
June	123.7
July	92.6
August	55.5
September	36.6
October	53.1
November	44.8
December	53.1

Source: World Weather Online, 2021, Sinaia monthly climate averages, https://www.worldweatheronline.com/sinaia-weather-averages/brasov/ro.aspx, Accessed on September 5, 2021 [17].

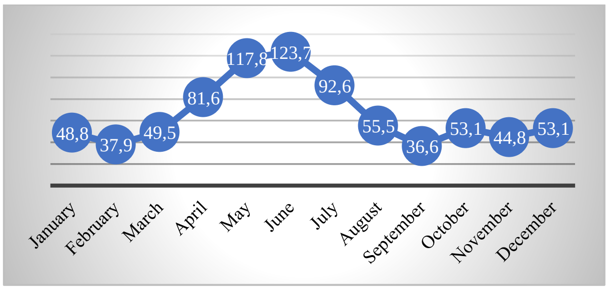

Fig. 9. The variation of the average monthly precipitation (mm) in Sinaia
Source: Own determination.

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Table 10. Annual average rainfall (mm) in Sinaia

Year	Sinaia
2009	45.60
2010	62.2
2011	57.49
2012	69.69
2013	53.64
2014	60.32
2015	55.07
2016	63.17
2017	53.97
2018	78.44
2019	197.28

Source: World Weather Online, 2021, Sinaia monthly climate averages, https://www.worldweatheronline.com/sinaia-weather-averages/brasov/ro.aspx, Accessed on September 5, 2021 [17].

During the 10 years, 2019 recorded impressive values compared to the rest of the years, this being attributed to climate change, with high rainfalls in both the hot and cold periods of the year.

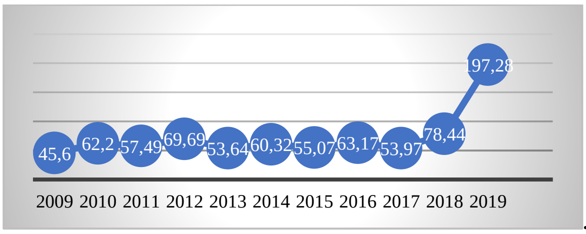

Fig. 10. The variation in annual rainfall (mm) in Sinaia
Source: Own determination

Wind is an important meteorological element that depends on the general circulation of the atmosphere, the movement of air currents depends on the activity of the centers of baric action as well as the different development of baric systems. It has three important features the direction from which it beats, the frequency and speed of movement expressed in m/s. In Sinaia the winds are heading from northwest to southeast [3].

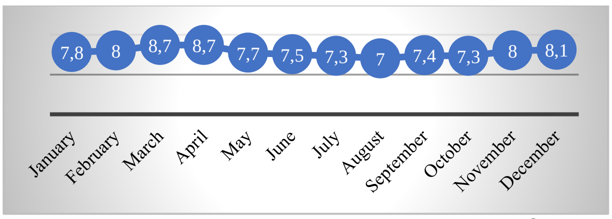

Fig. 11. Monthly average wind frequency (km^2/h) in Sinaia
Source: Own determination.

Thus, in Sinaia resort, the wind blows from the north with high frequency in July (43.4 of the total air movements), from the south in November (25.8%), from the east in June (2.5%), the one from west in June with (3.4%) and the highest frequency is in August with 28.4%. Annually it is registered over 29 days with speeds of 11-16 m/s, 3-4 days with over 16 m/s and the rest are with low speeds of 11m/s. The wind is very important for tourism, because it contributes to the way the human body feels the temperature. The higher its frequency, the higher the temperature felt by the human body, and tourists cannot fully enjoy it.

In Sinaia you can see in 2018 the lowest wind frequency of 6.8 kmph, while the highest value was observed in 2009 of 9.17 kmph.

Table 11. Annual average wind frequency (km/m^2) in Sinaia

Year	Sinaia
2009	9.17
2010	9.14
2011	8.95
2012	8.94
2013	9.14
2014	9.04
2015	8.01
2016	7.9
2017	7.71
2018	6.8
2019	7.19

Source: World Weather Online, 2021, Sinaia monthly climate averages, https://www.worldweatheronline.com/sinaia-weather-averages/brasov/ro.aspx, Accessed on September 5, 2021 [17].

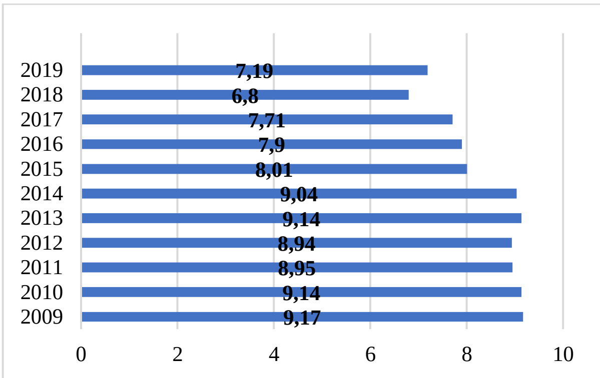

Fig. 12. Variation of the average annual wind frequency (km/m^2) in Sinaia
Source: Own determination.

Atmospheric risk phenomena

Atmospheric phenomena are a component of natural phenomena being influenced by relief, the altitudinal arrangement that has the effect of changing the intensity, character, frequency, components of the environment. The relief of Sinaia is characterized by the presence of mountains Bucegi, Postavaru, Garbova, Piatra Mare which intensifies the occurrence of risk phenomena such as avalanches, landslides and the presence of woody vegetation that leads to uniformity of snow, reduced wind speed and are recorded in the alpine floor the highest amounts of precipitation resulting in the condensation of clouds [5].

Being a city located on the Prahova Valley, there are phenomena such as frost, frost, soil frost with negative effects on agriculture [3].

Frost represents the decrease of air temperature and soil surface temperature reaching negative temperatures, usually below 0°C. The frost phenomenon manifests itself in autumn, most often taking place before October 1, and the last period of frost occurs in early June in mountainous areas.

Altitude helps to determine the number of days with frost, and the advection of cold masses consists of temperature differences. Frost is frequent in the mountainous area, especially in Sinaia due to the negative temperatures that set in with the arrival of the cold season. The frost is influenced by the height, which is why in the areas with low altitudes, respectively depressions and valley corridors, the number of days with frost is higher.

This climatic phenomenon can generate negative consequences in terms of tourist activities in mountain resorts. It can create a nuisance for tourists in areas where the snow layer is not very thick.

Also, in this region the following phenomena are felt: frost, icing, snow, blizzard, avalanches, torrential rains, hail, fog. They negatively influence the tourist activity, both in terms of resort supply, transport and tourist flows.

The influence of climatic conditions on tourist facilities and flows

The tourist arrangement consists in improving the accommodation and food spaces by modernizing them in order to satisfy the preferences of all tourists. For the development of the accommodation and food infrastructure, the natural and anthropic potential of the resorts for a better development of the tourist activity was taken into account.

Given that tourism in the mountain area has developed extremely much in recent years, investors in tourist facilities have modernized, refurbished in order to provide tourists with favorable conditions to spend their vacation. An example in this sense are the resorts on the Prahova Valley such as Sinaia, Busteni, Predeal, Azuga which compete in the offers and which can satisfy even the most demanding requirements of the tourists who cross their threshold.

Climatic elements have an important impact on tourist facilities and flows, as they determine the number of overnight stays in accommodation capacities. The natural potential is highlighted by the tourism planning plan of the city of Sinaia, which implicitly led to the increase of accommodation and catering infrastructure, being capitalized by several factors such as geographical location, tourist function, landscape quality, size and type of tourist activity.

The accommodation infrastructure has gradually developed over the ten years, as can be seen in (Table 12).

This being based on the evolution of tourism, so that in 2009 Sinaia had a number of 77 structures tourist reception, in 2019 it reached 89 tourist reception structures but the maximum of the structure being reached in 2017 by 96 tourist reception structures, the biggest extension is the hotels and tourist villas followed by tourist chalets and motels.

At the same time we can see that at present, hostels, motels, student and preschool camps have remained at the same number and did not evolve from 2009 to 2019, also, the tourist cottages showed an increase in 2012-2014 following that during the ten years to decrease dramatically, currently reaching 3 tourist reception structures (Fig. 13).

Table 12. Tourist reception structures with tourist accommodation function in Sinaia (2009-2019)

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Total tourist accommodation. units	77	77	83	84	89	89	87	85	96	95	89
Hotels	22	22	23	27	28	27	28	28	28	28	28
Hostels	2	3	3	3	2	2	2	2	2	2	2
Motels	2	2	2	2	2	2	2	2	2	2	2
Villas	22	23	21	15	13	12	11	10	13	13	12
Chalets	5	3	3	5	5	6	3	2	2	2	3
Camps for students and preschoolers	1	1	1	1	1	1	1	1	1	1	1

Source: National Institute of Statistics, 2021.

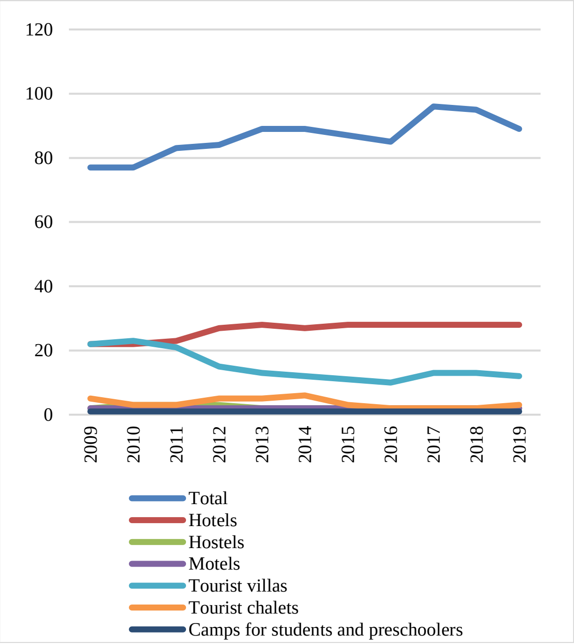

Fig. 13. Tourist accommodation structures in Sinaia (2009-2019)
Source: Own determination.

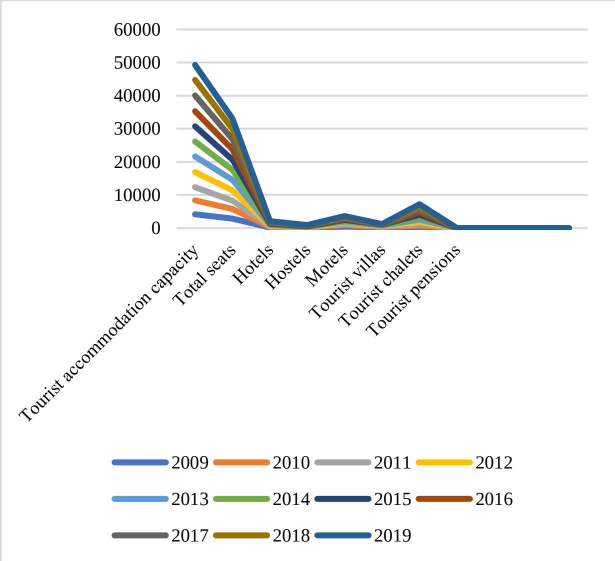

Fig. 14. Number of tourists distributed by accommodation units in Sinaia 2009-2019
Source: Own determination.

Table 13. Capacity and activity - Places- for tourist accommodation in Romania (2009-2019)

Hotels	Hostels	Motels	Tourist villas	Tourist chalets	Tourist pensions
2,869	110	72	479	189	373
2,877	195	72	462	119	378
2,543	195	72	411	119	518
3,110	218	72	320	161	579
3,131	189	86	322	161	708
2,984	189	86	272	173	708
3,124	189	86	253	75	765
3,108	189	84	257	45	771
3,110	201	108	290	45	826
3,105	201	108	276	75	797
3,099	201	108	262	73	738

Source: National Institute of Statistics [8].

Looking at the data from Table 13 we may notice that at national level se number of hotels is dominant, on the second positions are situated tourist guest houses, on the third position came tourist villas, followed by hostels, motels, and tourist chalets.

Tourist flows and the influence of climatic factors on them on the territory of Sinaia resort

Due to the climatic conditions and the relief, Sinaia resort offers tourists the opportunity to practice various forms of tourism, including winter sports, business and meeting tourism, hunting tourism and last but not least scientific tourism. Sinaia resort is known especially for weekend tourism, but also rural tourism being extremely widespread in the resorts [1].

As it can be seen from Table 14, in 2018 the arrivals of tourists who came to the accommodation units registered 305,800 compared only 165,233 in 2009.

Over the years, the resort of Sinaia has experienced an explosive growth, being currently among the most famous and visited resorts in the country. Compared to 2009, the number of arrivals has increased dramatically, this is highlighted by the impressive tourist

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attractions, but also the splendor of the city, as well as the possibility of practicing various winter sports.

Table 14. Number of arrivals and overnight stays in accommodation units in Sinaia (2009-2018)

	Arrivals of accommodated tourists	Overnight stays in accommodation structures
2009	165,233	403,352
2010	166,862	391,996
2011	174,616	397491
2012	98,157	452,920
2013	197,813	438,868
2014	198,064	440,190
2015	267,789	528,906
2016	289,993	585,224
2017	293,408	596,594
2018	305,800	657,073

Source: National Institute of Statistics [8].

Regarding overnight stays, the maximum value was reached in 2018 (Figure 15), when 657,073 people were mentioned, being preceded by 2017 by 596,594 people, subsequently decreasing in 2009-2010, from 403,353 to 391,996, followed by an increase in overnight stays.

This is due to the diversified tourist potential that attracts from one year to another, millions of tourists, eager to discover the so-called "pearl of the Carpathians"[15].

The number of overnight stays in the ten years indicates that Sinaia resort is chosen by visitors even during the weekend, when tourists want to relax and enjoy a short vacation [16].

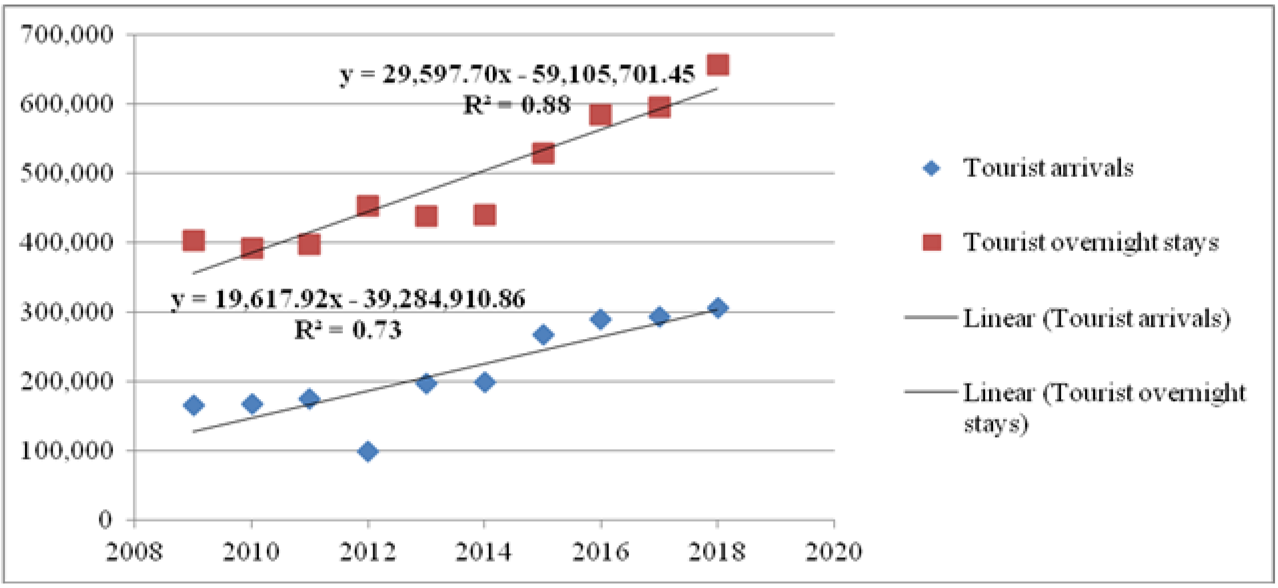

Fig. 15. Evolution of arrivals and overnight stays in accommodation units in Sinaia (2009-2018)
Source: Own determination.

Spa tourism and the influence of climatic factors on Sinaia resort

Spa tourism is one of the main forms of tourism found in Sinaia resort and is also the oldest type of tourism found in our country. It is highly exploited due to its natural potential and its location in a favored area.

Lately, spa tourism is also found in mountain areas, being much more beneficial due to the mountain air, free of allergens, clean, the mountain sun is a strong natural factor, which is indicated for strengthening and restoring the body.

Sinaia resort located on Prahova Valley, at heights between 767-1,055 m, offers tourists the opportunity to practice spa tourism due to the following therapeutic elements, namely clean bioclimate, without allergens, but also the existence of mineral water of Valea Câinelui spring, which has sulfur indicated for tourists with respiratory problems, for the treatment of hypertension, endocrinological and nervous disorders [7].

Tourists can enjoy baths with mineral water, carbon dioxide, herbs and electrotherapy that is achieved by exposure to ultraviolet radiation, as well as pulse currents or shortwave currents. For these therapies are provided to tourists qualified and authorized personnel for medical gymnastics, recovery, psychotherapy, massage, diet therapy, but also specially designed bases.

Tourism related to winter sports and the influence of climatic factors in Sinaia

Sinaia resort has a relief represented by mountains, this is a main advantage in practicing winter sports, being among the most sought after resort in the country.

Sinaia resort has a favorable climate for winter sports, with mild winters and low air currents.

Due to these characteristics, Sinaia resort enjoys a diversified natural tourism potential, for tourism related to winter sports, climatic parameters being the main attraction, the most significant being represented by the thickness of the snow layer and its duration.

Within the resort, there are cable transport facilities that help to transport tourists in more inaccessible areas - cable cars, chairlifts, ski lifts. You can practice skiing, mountaineering, hiking, hiking.

Weekend tourism and the influence of climatic factors on it

Weekend tourism has become extremely popular lately, especially by tourists who live in urban areas and who want to enjoy a mini vacation in nature. An escape to the mountains is often dedicated to relaxation and rest, being practiced especially by tourists who do not have several days off. Weekend tourism is practiced in any season. Weekend tourism arose from the need of people to explore the new place, in a short period, choosing as the main structure of tourist reception the pensions due to the quality-price ratio [2].

Climatic factors play an important role in the realization of weekend tourism, especially in the winter season. The presence of the snow layer is the most important climatic element that attracts many tourists to practice winter sports. Also, wind speed and air temperature are important in order to perform optimally for winter sports. During the cold season, the resorts are crowded, Romanian and foreign tourists enjoy the slopes with varying degrees of difficulty, as well as mountain hiking on marked trails [2].

Distribution of private accommodation infrastructures within Sinaia resort

The private accommodation infrastructure in Sinaia (Table 15 and Figure 16) is represented by the tourist villas and tourist chalets. Thus, the tourist villas are the most numerous accommodation units of this type, while the tourist chalets are approximately equal. The largest share of tourist villas in Sinaia resorts is in 2010 and will decrease dramatically during that period.

Table 15. Private accommodation infrastructure in Sinaia 2009-2019

Sinaia	Tourist villas	Tourist chalets
2009	22	5
2010	23	3
2011	21	3
2012	15	5
2013	13	5
2014	12	6
2015	11	3
2016	10	2
2017	13	2
2018	13	3
2019	12	3

Source: National Institute of Statistics [8].

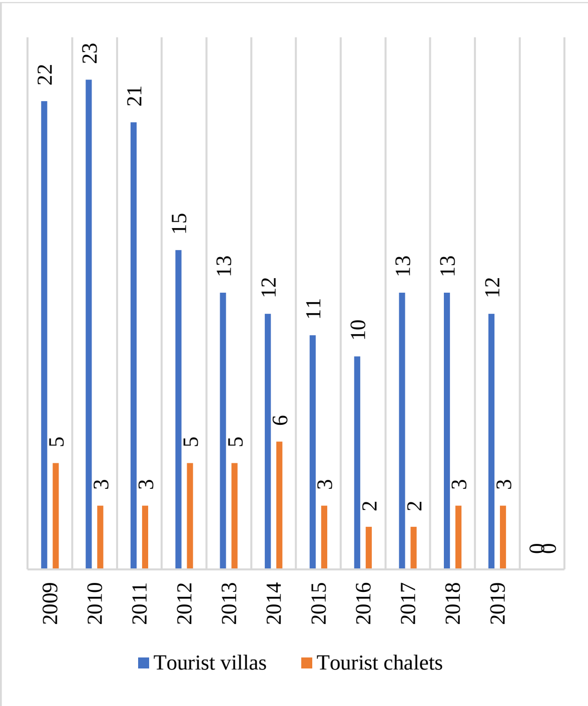

Fig. 16. Variation of private accommodation infrastructure in Sinaia 2009-2019
Source: Own determination.

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The lowest number of private accommodation infrastructure is observable in 2016, and currently (2019) Sinaia has a relatively small number of tourist chalets. Tourist villas are the most used forms of accommodation, after hotels and tourist pensions due to the fact that they are more accessible and can be used by groups of families or friends.

Distribution of accommodation units in relation to their degree of comfort

The hotels in this area are classified according to the facilities expressed in number of stars and the pensions in number of daisies, in order to offer tourists the possibility to enjoy their benefits [4] (Table 16 and Fig. 17).

Table 16. The structure of the main accommodation units in the degree of comfort in Sinaia (2009-2019)

Degree of comfort	**Hotels**	Tourist pensions
1 star	0	
2 stars	4	
3 stars	12	
4 stars	8	
5 stars	1	
2 daisies	-	1
3 daisies	-	6
4 daisies	-	3
5 daisies	-	3

Source: Ministry of Economy, Antrepreneurship and Tourism, 2021, Tourism authorization, http://turism.gov.ro/web/autorizare-turism/, Accessed on Sept. 3, 2021 [6].

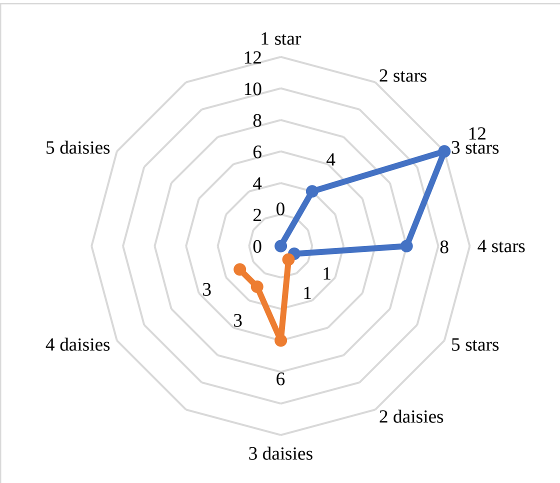

Fig. 17. Variation of the main accommodation units and degree of comfort in Sinaia (2009-2019)
Source: Own determination.

Tourist flows in Sinaia resort during 2009-2019 by tourist origin

In 2019, Sinaia resort was visited by 573,557 tourists, of which 442,911 Romanians (77.22%) and 130, 646 foreigners (22.78%) (Table 17).

Table 17. Number of tourists arriving in Sinaia (2009-2019)

Year	Romanian tourists	Foreign tourists
2009	181,423	64,782
2010	219,866	65,322
2011	267,603	80,109
2012	252,727	78,472
2013	273,494	89,693
2014	293,766	101,056
2015	349,676	115,876
2016	376,900	128,321
2017	400,630	139,502
2018	370,913	129,363
2019	442,911	130,646

Source: National Institute of Statistics [8].

Following the data collected, there is a higher number of Romanian tourists than foreigners who crossed the threshold of Sinaia resort (Figure 18).

Nicknamed "Pearl of the Carpathians", Sinaia is a luxury resort with tourist attractions worthy of envy by mountain resorts outside Romania [7].

The former residence of the kings, attracted the largest number of foreign visitors in 2017, while the maximum threshold reached by Romanian visitors was reached in 2019, being considered by the accommodation units, as the best year from an economic and tourist point of view [12].

With tourist attractions loaded with a rich history, a legend around the world and impressive building architecture, Sinaia has managed to conquer a remarkable number of tourists and become an attractive city that combines the beauty of nature with the castles that made it famous.

The diversity of natural and anthropic landscapes, the possibility of practicing winter sports, and the fresh mountain air are the key points that define the Sinaia resort.

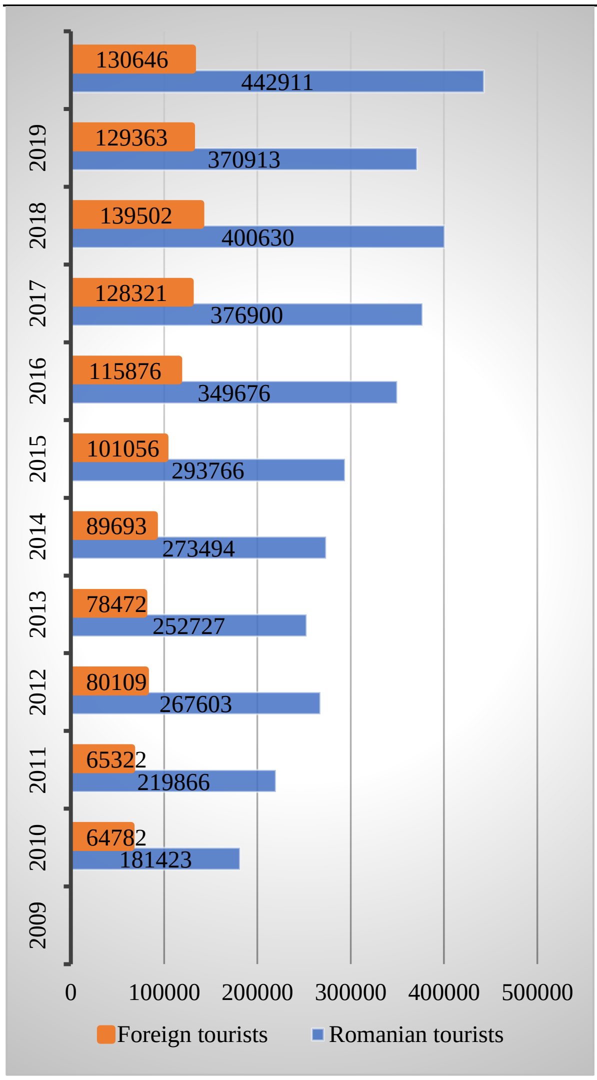

Fig. 18. Variation in the number of tourists arriving in Sinaia (2009-2019)
Source: Own determination.

CONCLUSIONS

The favorable geographical position and the relief complement the climatic framework that favors the development of the tourist activity throughout the year.

Tourism is based on spending time outdoors, practicing winter sports during the cold season, being the busiest time of year in Sinaia.

The exceptional mountain landscapes, the unique tourist objectives and the possibility to practice several mountain activities, make Sinaia the favorite resort of Romanian tourists and those from abroad.

Once they arrive here, tourists can admire the beauty of nature, can explore it through hiking but can also be cured of various ailments, by following the treatment in the spas found in the area.

The accommodation infrastructure has gradually developed over the ten years. This being based on the evolution of tourism, so that in 2009 Sinaia had a number of 77 structures tourist reception, in 2019 it reached 89 tourist reception structures but the maximum of the structure being reached in 2017 by 96 tourist reception structures, the biggest extension is the hotels and tourist villas followed by tourist chalets and motels.

The tourist accommodation capacity in Sinaia has a high share in 2017 of 4,769 places.

Regarding overnight stays, the maximum value was reached in 2018, when 657,073 people were mentioned, being preceded by 2017 by 596,594 visitors, subsequently decreasing in 2009-2010, from 403,353 to 391,996, followed by an increase in overnight stays.

The accommodation units are diversified, the tourist being able to choose according to his preferences, from campsites to more luxurious hotels, with more benefits so that each tourist's vacation is a unique and pleasant experience, to satisfy his desire to return, within these tourist resorts.

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QUANTITATIVE AND QUALITATIVE ANALYSIS OF TRADITIONAL CHEESE PRODUCTION IN ROMANIA

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Abstract

Certification of traditional products is a voluntary quality scheme, recognized in the EU, which provides producers with viable tools to identify and promote products. The national regulation was issued in compliance with the provisions of Government Decision no. 1,016/2004 on measures for the organization and implementation of information exchange in the field of technical standards and regulations, as well as the rules on information society services between Romania and the Member States of the European Union, as well as the European Commission, as subsequently amended and supplemented. Among the conditions for attesting traditional food products is the production capacity of one or more products. The indicator on the maximum quantity of certified product/products regulated by the specific normative act allows and encourages the agricultural activities of small producers in rural areas, which have an important role in the rural economy and, in particular, in disadvantaged areas. The sustainable development of products belonging to this niche will ensure the sustainability of traditional production and the maintenance of local traditions. The traceability of agri-food products, by applying and developing the concept of "short agri-food chain" will provide consumers with fresh food from local production, at affordable prices. Easy information of consumers interested in these products is possible due to the creation and posting on the Ministry of Agriculture and Rural Development- MARD website of the National Register of Traditional Products. Through this paper, an analysis of traditional products in the category of dairy products and cheeses has been made, so as to identify the potential and promote its use for areas in Romania by registering such products, using in this sense the statistical basis of information of the National Institute of Statistics, NIS, in terms of livestock.

Key words**:** *registration of traditional products, sustainability, short agri-food chain, rural development*

INTRODUCTION

Before Romania's adhesion to the European Union, at national level, specific legislation was adopted for the protection of food categories whose tradition was well-known. Thus, the traditional product was defined for the first time in the MARD Order no. 690/2004, respectively "the product to be obtained from traditional raw materials, to present a traditional composition or a mode of production and/or processing that reflects a traditional technological process of production and/or processing and that is distinguished in clearly of other similar products belonging to the same category".
This normative act has been subject to modifications/completions in order to improve and perfect, at present, being represented by Order no. 724/2013 with subsequent amendments and completions which makes it possible for the quality scheme governing the attestation of traditional products to be accessible not only at national level but also to producers belonging to other Member States.
Having regard to the fundamental principles of the two strategies implemented by the new CAP, namely the Fork to Fork Strategy and the European Green Pact [2], in order to ensure the sustainability and sustainability of the agri-food sector, MARD, through the Strategy for the development of the agri-food sector medium and long term Horizon 2020-2030 aims to capitalize on the traditional potential of the local rural space [4].

The promotion and capitalization of these niche products whose intrinsic value is conferred by the preservation and cultivation of gastronomic habits, regional and national traditions, must correspond to the requirements and profile of consumers and at the same time respect the rules of food safety and nutrition [6].

Certification and marketing of traditional products are viable tools to identify and promote products in an easy, impactful and easily recognized way to support and promote small producers, with effect on the development of the rural economy, consumer awareness of the quality and authenticity of these products.

The concern for increasing the number of traditional products, through the use of simple recipes is justified by the importance and need for superior capitalization of local raw materials, promoting the short agri-food chain [1].

What distinguishes the category of these products from other similar foods are, in addition to the use of local raw materials, the lack of food additives in their composition, the use of a traditional recipe, a traditional mode of production and/or processing.

The benefits generated by these products consist in the socio-economic impact and protection of the environment, by creating jobs in rural areas, preserving and capitalizing on local dowry, creating a supply of healthy and nutritious food, cultivating consumer respect and awareness national culture and tradition [7].

In order to increase the visibility of Romanian products, in general, and explicitly of traditional products with a strong local/ regional imprint which represents, by their very name, a national geographical area / area, specific legal instruments are created by the European Commission (regulations for their registration on quality schemes (DOP, IGP, STG) (Table 1).

Consumer preferences and orientations for traditional products are determined not only by the physiological need from a nutritional point of view but also by factors such as distinct olfactory and gustatory properties related to the emotional memory of childhood, for the aromas of goodies prepared by grandparents [5].

Table 1. The main systems in the field of agricultural and food quality

Protected Origin Designation (PDO)	(a) designation of origin: means the name of a region, a specific place or, in exceptional cases, a country, used to describe an agricultural product or a foodstuff: — originating in that region, specific place or country, and — the quality or characteristics of which are essentially or exclusively due to a particular geographical environment with its inherent natural and human factors, and the production, processing and preparation of which take place in the defined geographical area;
Protected Geographical Indication (PGI).	(b) geographical indication: means the name of a region, a specific place or, in exceptional cases, a country, used to describe an agricultural product or a foodstuff: — originating in that region, specific place or country, and — which possesses a specific quality, reputation or other characteristics attributable to that geographical origin and the production and/or processing and/or preparation of which take place in the defined geographical area.
Traditional Specialty Guaranteed (STG)	(c) defines a traditional agricultural or food product whose specificity has been recognized by the European Community by its registration in the register. The name in order to be registered must express the specificity of the food or agricultural product. Traditional specialty guaranteed does not refer to an origin, but in order to obtain protection, the product must have a traditional composition (recipe) or a traditional way of production. The raw materials or the mode of production give the product the traditional character in relation to other products. To gain recognition, a product must be on the market for at least 30 years.

Source: Regulation EP no. 1151/2012 [3].

The concept of quality of traditional products is complex, including a multitude of factors that define it: the qualitative value of local raw materials and ingredients used, the traditional technological process used, the specific local production method, authentic and invariable, and the packaging used, storage and transport conditions.

With regard to the category of dairy products and cheeses which is the subject, we note that, in order to be certified as traditional products, the following are necessary and decisive: the raw milk must come from the country where the finished product is obtained, which contains additives obtained by chemical synthesis (food additives, flavors, vitamins, minerals); the ingredients used in the preparation of the product must meet the same conditions as regards the composition, ie they must not contain additives obtained by chemical synthesis; the specific local production method and/or technological process must present an element or set of elements by which a product differs from other similar products belonging to the same category, giving the product tradition quality.

MATERIALS AND METHODS

The purpose of this research is to perform a quantitative and qualitative analysis of traditionally certified products in Romania, and especially those in the category of dairy products and cheeses, so as to identify the local potential of such products and promote them in order to capitalize on the materials. local prime.

The information source was Ministry of Agriculture and Rural Development, National Register of traditional products.

Currently, in Romania there are 710 traditionally certified products, of which a number of 127 is the category of dairy products and cheeses, meaning a percentage of 18 of the totals (as of 1.04.2021) (Fig. 1) [8].

For the cheese category, the interpretation of the graph above demonstrates a discrepancy between Brașov County (mountain area) where the maximum share of traditionally certified cheeses is found and other areas of Romania, where the distribution of these products is balanced between counties but obviously much smaller.

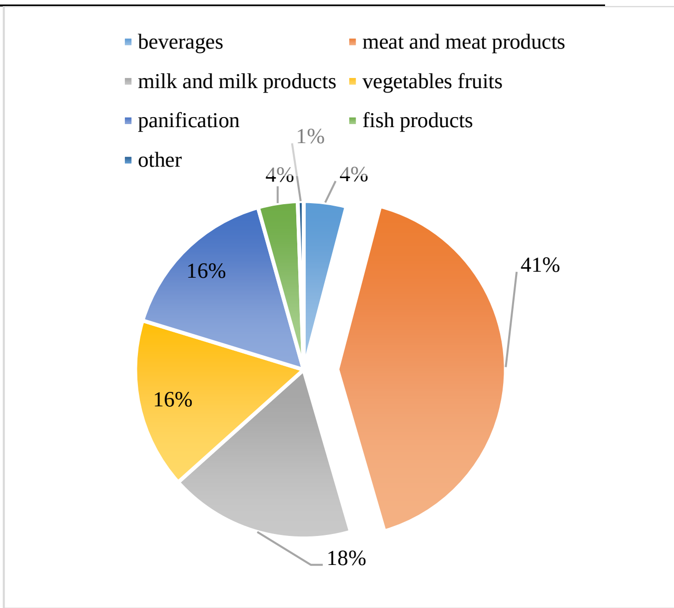

Fig. 1. Share of the number of traditional products certificates depending on the product category
Source: www.madr.ro [8].

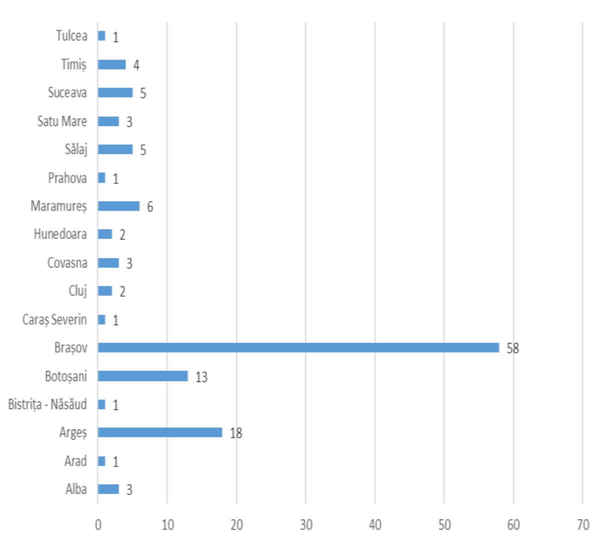

Fig. 2. Situation by counties of traditionally certified dairy products and cheeses
Source: www.madr.ro [8].

Table 2 shows that the percentage of matured products is higher than fresh ones justified by the fact that the shelf life of matured products is longer than that of fresh ones and that their price is higher than the price of fresh dairy products; It should also be noted that consumer demand dictates the direction of producers in forecasting/planning their production.

Table 2. Distribution by county of traditionally certified products in the category of dairy products and cheeses

County	Matured product	Fresh product	total
Alba	3		3
Arad	1		1
Argeș	15	3	18
Bistrița - Năsăud	1		1
Botoșani	10	3	13
Brașov	45	13	58
Caraș Severin	1		1
Cluj	2		2
Covasna	2	1	3
Hunedoara	2		2
Maramureș	3	3	6
Prahova	1		1
Sălaj	4	1	5
Satu Mare	3		3
Suceava	4	1	5
Timiș	3	1	4
Tulcea	1		1
TOTAL	101	26	127

Source: www.madr.ro [8].

Analyzing the situation presented in Table 3, it follows that the share of raw materials used in the preparation of dairy products and cheeses is milk from cow species, followed in a decreasing trend by sheep's milk, mixed milk (cow + sheep), and goat's milk.

Table 3. Distribution by county of traditionally certified products in the category of dairy products and cheeses according to the species of animal from which derives the raw material

County	Goat's milk	Mixed milk	Sheep's milk	Cow milk	Total
Alba		1	1	1	3
Arad		1			1
Argeș		3	6	9	18
Bistrița - Năsăud				1	1
Botoșani				13	13
Brașov		22	27	9	58
Caraș Severin	1				1
Cluj				2	2
Covasna				3	3
Hunedoara			1	1	2
Maramureș		4		2	6
Prahova				1	1
Sălaj	5				5
Satu Mare	2		1		3
Suceava		2		3	5
Timiș			1	3	4
Tulcea	1				1
Total	9	33	37	48	127

Source: www.madr.ro [8].

The analysis of the two graphs Fig. 3 and Fig. 4 below shows that the largest number of bovine animals is found on individual farms, compared to the number of bovine animals providing raw material for the private sector, which indicates that the raw material is not capitalized sufficiently (it is not transformed into value-added products).

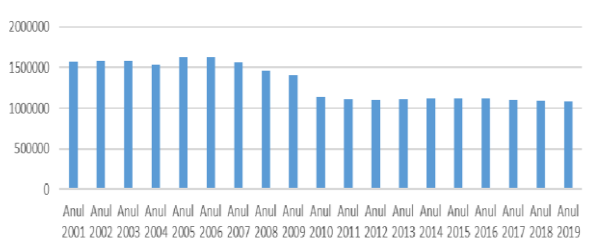

Fig. 3. Herds of animals/cows at national level, in the form of property of individual agricultural holdings
Source: http://statistici.insse.ro/ [9].

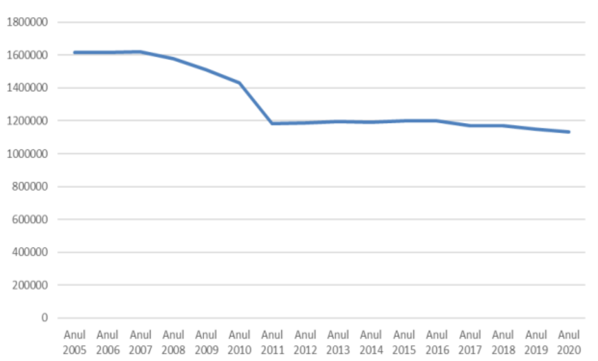

Fig. 4. Evolution of cattle (dairy cows) between 2005-2020
Source: http://statistici.insse.ro/[9].

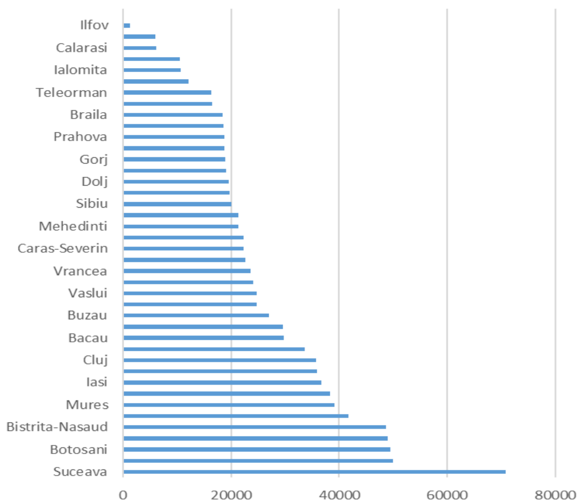

Fig. 5. Distribution of cows by counties in individual farms, in 2019
Source: http://statistici.insse.ro/ [9].

Thus, it is necessary for public policies to ensure producers' awareness of the need and benefits provided by, on the one hand, the processing and, on the other hand, the registration of products on the quality scheme “traditional product”.

Fig. 5 shows that, although there are counties/ areas with important potential (of which Suceava is in the first place) in terms of raw materials, they are insignificantly represented in the National Register of Traditional Products.

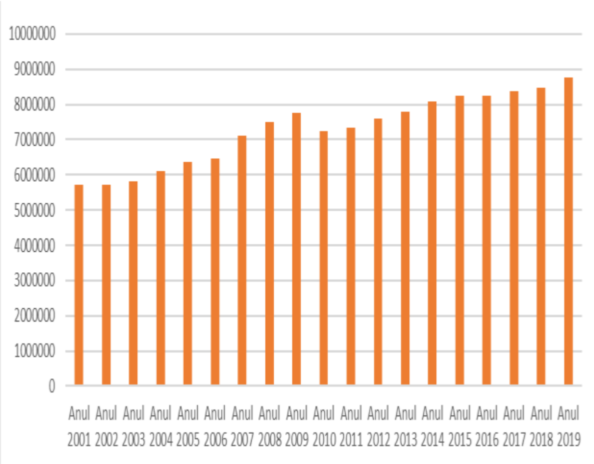

Fig. 6. Herds of animals/sheep species at national level, in the form of property of individual agricultural holdings
Source: http://statistici.insse.ro/ [9].

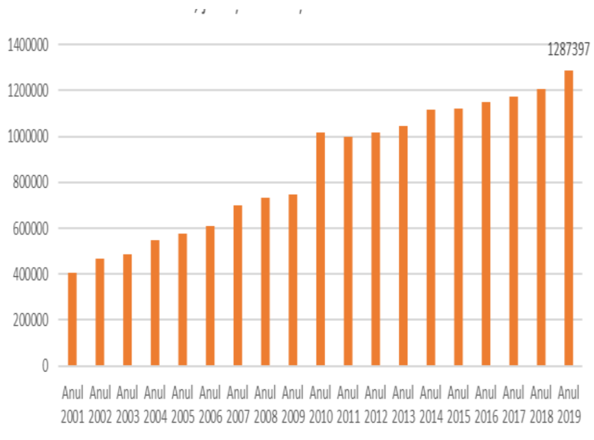

Fig. 7. Herds of animals/goat species at national level, in the form of property of individual agricultural holdings
Source: http://statistici.insse.ro/ [9].

The analysis of the graphs on the distribution of sheep and goat herds provides the same conclusions as for cattle herds. It should be noted that Sibiu County has the most livestock of sheep and superior value of milk from this species, Telemeaua de Sibiu (Cottage cheese of Sibiu) representing a brand for Romania, being registered at European level, since 2019, as a Protected Geographical Indication.

RESULTS AND DISCUSSIONS

Currently, according to statistical data from the National Register of Traditional Products (RNPT), in Romania there are 43 economic operators whose object of activity is the manufacture of dairy products and cheeses, whose distribution is shown in the map in Fig. 8 below.

Fig. 8. Identification of producers whose activity is from the category of dairy products and cheeses in Romania
Source: www.madr.ro [8].

In Table 4 the organoleptic and physical-chemical properties are presented for the representative products in the category of matured cheeses, attested at national level [10].

The values of the organoleptic and physical-chemical parameters found in Table 5 were extracted from analysis bulletins/test reports performed by specialized laboratories, authorized and accredited in accordance with the national legislation in force.

Table 4. Organoleptic properties of dairy products and cheeses registered as a traditional product

Organoleptic properties for products in the category of cheese with scalded paste (cheese) registered as a traditional product			
aspect	Color	Taste and smell	consistency
Pressed Cheese from Botoșani County Obtained by: from whole cow's milk, unpasteurized, coagulated with natural curd. Belongs to the category of scalded cheeses			
Exterior: smooth surface, clean, without wrinkles, without stains or cracks.	White-yellow color, even	pleasant uniform, slightly salty, characteristic of scalded cheeses..	clean, compact, homogeneous paste with a fine, creamy, slightly elastic consistency, which breaks into strips when torn
Pressed Cheese from Argeș County Obtained by: from raw cow's milk, fresh, coagulated with natural curd, and the obtained curd is scalded in brine			
The external appearance is in the form of wheels and parallelepiped bars of different uniform sizes, without shell with a uniform whole appearance and without cracks.	the color of the product is light yellow, uniform throughout the table keeping the same color both on the outside and inside	Characteristic of scalded and matured cheeses made from cow's milk, without foreign smell and taste	Unctuous fine paste, homogeneous, compact without traces of mold, slightly elastic, when torn breaks into strips
Pressed Cheese from Maramureș County Obtained by: from raw, fresh, unsweetened cow's milk, curd with natural curd, and the curd obtained is scalded in brine, without the addition of preservatives or food additives			
The external appearance of the semitic paste	the color of the product is white-yellow, with a pleasant taste and the characteristic aroma imprinted by the flora of the pasture in the production area	Characteristic of scalded and matured cheeses made from cow's milk, without foreign smell and taste	Slightly elastic fine consistency, when broken it breaks into strips, glossy on the surface, with a thin shell
Pressed Cheese from Suceava County Obtained by: from raw cow's milk, fresh, coagulated with natural curd, and the curd obtained is scalded in brine and whey			
Uniform appearance, peel without spots or cracks	the color of the product is white-yellow to yellow	The taste is pleasant, slightly salty with the aroma specific to fresh milk; pleasant smell specific to scalded cheeses	Semi-hard, slightly elastic, when broken it breaks into strips
Pressed Cheese from Brașov County Obtained by: made of raw, fresh cow's milk, coagulated with natural curd			
Uniform appearance, peel without spots or cracks	the color of the product is white-yellow to yellow	Taste and pleasant smell, specific to scalded cheeses	Paste with very rare fermentation mesh, with small mesh formation
Pressed Cheese from Botoșani County Obtained by: of raw cow's milk, fresh, coagulated with natural curd, and the curd is scalded in wicker baskets			
Uniform appearance, peel without spots or cracks	the color of the product is white with yellowish hues	Taste and pleasant smell, specific to scalded cheeses	Hard, slightly elastic, rough, floury paste is not allowed
Pressed Cheese from Prahova County Obtained by: from raw, fresh cow's milk, coagulated with natural curd, and the curd obtained is scalded in mineral-rich brine from underground sources. The product can also be cold smoked			
Uniform appearance, peel without spots or cracks	the color of the product is white with yellowish hues	Taste and pleasant smell, specific to scalded cheeses	Hard, slightly elastic, rough, floury paste is not allowed

Source: Own determination.

Table 5. Physical-chemical characteristics of dairy products and cheeses, registered as a traditional product

Physical-chemical characteristics				
Product	Fat reported to SU, % (min)	Humidity, % (max)	SU % (min)	NaCl % (max)
Cheese from Botoşani	40	45	50	3
Cheese from Argeş	40	48	40	3,5
Cheese from Maramureş	44	43	56	2
Cheese from Suceava	44	45	56	2
Cheese from Braşov	42	50	50	3
Cheese from Botoşani	45	43	56	3
Cheese from Prahova	45	43	55	3

Source: Own determination.

CONCLUSIONS

In the context in which sustainable development has long been a concern and a desire for the European Union and taking into account the particularities and specificities of each Member State, it is necessary for Member States to identify ways and levers to contribute to achieving this goal.

By subscribing to the European social model, it is vital to pursue the key objectives of promoting a sustainable economy, on the one hand, by raising awareness of the models offered by sustainability in the agri-food sector, in order to ensure the transition to a sustainable economy. circular, characterized by low carbon emissions, resilience to climate change and efficient use of natural resources, as well as the creation of new jobs to stop the migration of the population from the village to the city.

The concern for the promotion of agri-food products on quality schemes is to make it mandatory for Member States to allocate 30% of Pillar I payments to ensure additional payments for four schemes that would be voluntary for farmers (organic farming, permanent grasslands, facing areas). with natural constraints and linear landscape elements), with the aim of sustainably managing natural resources and combating climate change, and

Although the competent institutions at both European and national level have regulated a specific legislative framework that provides opportunities/support measures to stimulate agri-food producers to access quality schemes, Romania's important agri-food potential is not sufficiently exploited in this sense.

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FARM STRUCTURE IN ANIMAL SECTOR OF ROMANIA

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Abstract

The paper aimed to analyze the number of animal holdings, their structure by species and size class and also the average farm size based on the data provided by Eurostat and National Institute of Statistics. Fixed and structural indices as well as comparisons were the main statistical tools to assess the results. Romania has a high number of animal farms being on the top position in the EU, but the smallest farm size. The decline of bovine, swine and poultry livestock has relatively contributed to the growth of farm size and production efficiency. About 72.7% of agricultural holdings have land and animals and 23.3% rear only animals. Individual holdings are dominant and keep 86.9% bovine farms, 53% pig farms, 93.3% sheep farms, 95.1% goats farms and 67.4% poultry farms. Commercial holdings represent 44.4% of pig farms and 31.7% of poultry farms de very small percentages in case of the other species. At the national level, the average farm size of animal farms is: 3.4 bovines, 2.4 dairy cows, 3.2 pigs, 43.7 sheep, 10.6 goats and 31.6 poultry. A smaller average farm size is in the individual holdings: 2.9 bovines, 2.2 dairy cows, 1.7 pigs, 41.3 sheep, 10.1 goats and 18.7 poultry. Commercial companies have in average a higher average size: 211 bovines, 97.8 dairy cows, 7,878 pigs, 942.6 sheep, 181.7 goats and 96,009.2 poultry. The gap between individual and commercial holdings is difficult to be reduced, as long as farm concentration is a slow process. The decline in livestock, farmers aging and the new modern farms established with EU financial support are expecting to contribute to the improvement of farm structures in animal sector.

Key words: *animal sector, farms structure, average farm size, individual households, commercial companies, Romania*

INTRODUCTION

Agriculture is an important sector of the economy in any country as it provides food for population, raw materials for various processing industries, jobs and income for the rural population. Combining in its own way the three production factors: land, labor and capital, cultivating agricultural crops and rearing animals, using various technologies, part of them friendly with the environment, selling its products on the market, it also contributes to the increase of gross domestic product, gross value added, and trade intensification, to the improvement of living standard and environment protection.

Therefore, agriculture creates a bridge of interconnections between economic, social and environment factors destined to contribute to the sustainable development [31, 39, 47, 49].

The role of agriculture is carried out by farms and farmers called to transform the inputs into high value products and goods for keeping life and satisfying much better humans' needs.

Agricultural production is running in farms of different profile, size, technical endowment, material and financial resources, labor qualification, technologies applied, and also in various geographical areas, soil and climate conditions and facing more and more with the challenges produced by climate change [54].

Productivity and efficiency in agriculture is closely related to farm structure. The EU agriculture has a large diversity of farm structures with a deep influence on land concentration, and despite that this is a slow process, the last 15 years the number of agricultural holdings has been reduced in favor of average farm size [6, 7, 16, 18].

The high number of agricultural holdings, most of them being small scale farms, and the domination of family farming are the main features of the EU agriculture and especially in the CEEs countries [1, 3, 14, 55].

Therefore, many small farmers have to sustain their business trying to continuously respond to market requirements, to adapt technologies and improve product chain from farm to fork looking for solutions to enable them to pass from subsistence and semi-subsistence to commercial farming [15, 32].

In 2016, of the EU-28 agricultural holdings accounting for 10.5 million, 90% belonged to family farming, which proved to play a crucial role in assuring employment, income and living standard for rural population [13].

Romania occupies a special position in the EU agriculture as it joined EU in 2007 with a high number of farms, with a deep fragmentation of land into small plots, most of farms being of a subsistence and semi-subsistence type, with many old fashioned farmers accustomed to work land and raise animals in a traditional way, having an obsolete endowment, low productivity and efficiency and family farming being dominant [20].

Animal sector has diminished its importance in agricultural production value due to the decline of bovine, swine and poultry livestock, and in 2020 it contributed with about 30% in the agricultural production value as mentioned by National Institute of Statistics.

In Romania the number of animal farms is high and of a diverse size, mainly of small scale, the farmers fight to survive and cover the market needs, but the deficit between supply and demand has led to the increase of imports of various food of animal origin, mainly from the EU countries [47].

In Romania just a few studies provides results regarding the farm structure in animal sector [17, 19, 27].

In this context, the purpose of the paper was to analyze the structure of agricultural holdings raising animals in Romania by species, and size class in terms of animals. Also, another purpose is to determine the average farm size expressed in number of animals per farm and to make a comparison between the average farm size in the individual households which are dominant and the average farm size in the commercial companies with majority private capital.

MATERIALS AND METHODS

The data were taken from Eurostat and also from National Institute of Statistics data bases regarding the last farm survey achieved in 2016, which is the only available source of data till present as the next farm survey is planned by the EU to be done in 2023.

The main indicators analyzed in this research are the following ones:

- number of agricultural holdings raising animals;
-number of livestock by species, taking into account only the main species: bovines, swine, sheep, goats and poultry;
-number of individual holdings raising animals;
- number of livestock raised by individual holdings;
-number of commercial companies raising animals;
- number of livestock grown by commercial companies;
-average farm size by species and average farms size by species and size class for all the agricultural holdings;
-average farm size by species in individual holdings and average farms size by species and size class for individual agricultural holdings;
- average farm size by species in commercial companies with majority private capital and average farms size by species and size class for commercial companies.

The data were processed using especially fixed indices, structural indices and comparisons between the average farm size in the individual agricultural holdings and commercial companies.

The results of the calculations regarding farm structure for various criteria of analysis were tabled and interpreted and allowed to draw the corresponding conclusions!

RESULTS AND DISCUSSIONS

Romania -top position in the EU for the number of agricultural holdings

Romania is in the top regarding the number of farms in the EU. In 2016, it had 3.42 million agricultural holdings, representing 32.6% of the EU farms.

Romania is followed by Poland (13.4%), Italy (10.9%), Spain (9%), Greece (6.5%), France (4.3%), Hungary (4%), Germany 2.6%, Portugal 2.4% and Bulgaria (1.9%) [11].

In the period 2005-2016, the EU number of holdings declined by 25%, meaning a loss of 4.2 million farms, about 85% of them being small farms having less than 5 ha. In the same period of time, Romania lost -20% farms, being on the 2nd position after Poland (- 43%) and being followed by Italy (-34%).

Animal farms in the EU are very important for providing food of animal origin and raw materials for processing industry. In the EU the ratio vegetal/animal sector is relatively balanced as 49% of farms are dealing with crop culture, 35% farms are specialized in animal farming and 16% are mixed holdings [12].

The main EU member states with the highest number of animal holdings are: Romania, Poland, Hungary, France, Greece, Spain, Germany, Portugal, Italy and Bulgaria (Table 1).

Table 1. The top EU countries raising animals in 2016

	No of agricultural holdings	Of which, farms with livestock	Share of animal farms in total agricultural holdings (%)
1.Romania	3,433,030	2,567,430	75
2.Poland	1,410,700	718,240	50.9
3.Hungary	430,000	261,540	60.8
4.France	456,520	247,570	54.2
5.Greece	684,950	238,520	34.8
6.Spain	945,020	216,700	22.9
7.Germany	276,120	184,690	66.8
8.Portugal	258,980	172,350	66.5
9.Italy	1,145,710	154,680	13.5
10.Bulgaria	202,720	134,970	66.5%

Source: Own calculation based on Eurostat, 2017 [10].

In 2016, Romania had 39% crop farms, 25% animal farms and 36% mixed farms.

Animal output and its contribution to agricultural output in Romania

Animal sector plays an important role in Romania's agriculture and gives its contribution to agricultural output. In 2020, animal output accounted for Euro 3,258 million representing 27.7% of agricultural output of Romania and also 2.6% of the EU agricultural output as mentioned by Eurostat (Table 2).

Table 2. Dynamics of animal output and its share in agricultural output, Romania, 2016-2020 (Euro million)

	2016	2017	2018	2019	2020	2020/2016%
Agricultural output	12,356	13,622	14,039	13,612	11,752	95.11
Animal output	3,375	3,509	3,134	3,107	3,258	96.53
Share (%)	27.3	25.7	22.3	22.8	27.7	-

Source: Own calculation based on Eurostat Fact Sheet Romania, 2019 and 2021 [8, 9].

However, both agricultural output and animal output registered a descending trend in the period 2016-2020 due to the decline in livestock (bovines, pigs, poultry), except sheep and goats, and also due to climate change which affected crop and fodder production and other factors.

In 2020, in total animal output, animals accounted for Euro 1,600 million (49.1%), the main contributors being pigs, cattle, poultry and sheep and goats, and animal products mainly regarding milk and eggs, accounting for Euro 1,658 million (50.9%) (Table 3).

In the period 2016-2020, the share of animal output increased by +1.3 pp from 47.8% in 2016 to 49.1% in 2020, while the share of animal products declined by -1.3 pp from 52.2% to 50.9%.

In 2020, the highest weight in animal products belonged to milk (25.3%), pigs (22.6%), eggs (15.7%), and also to poultry (12.8%) and cattle (8.5%).

Table 3. Structure of animal output by sources, Romania, 2016-2020 (%)

	2016	**2017**	**2018**	**2019**	**2020**	**2020/2016 %**
Animal output (Euro million)	3,375	3,509	3,134	3,107	3,258	96.53
Contribution of animals and animal products to animal output (%; pp)						
Animals	47.8	47.5	46.9	48.5	49.1	+1.3
-Cattle	8.7	7.2	7.2	6.8	8.5	-0.2
-Pigs	20.9	23.1	21.9	22.8	22.6	+1.7
-Sheep and goats	5.0	4.7	5.1	5.3	4.9	-0.1
-Poultry	12.7	11.7	12.4	12.8	12.8	+0.1
Animal products	52.2	52.2	53.1	51.5	50.9	-1.3
-Milk	26.4	26.6	24.5	24.4	25.3	-1.1
-Eggs	17.7	17.1	13.6	17.7	15.7	-2.1
Other products	8.0	8.8	9.9	9.3	9.9	+1.9

Source: Own calculation based on Eurostat Fact Sheet Romania, 2019 and 2021 [8, 9].

Cattle, especially dairy cows and buffalos bring their major contribution accounting for about 97% of milk production, and sheep and goats to the rest of about 3%. They play an important role in assuring farmers family consumption, but also for providing raw milk to dairies [36, 37, 45]. However, milk market needs are not covered by internal production, and imports of dairy products are justified [44, 46, 53].

Dairy farming is facing the decline of the number of dairy cows, low yield, insufficient forages due to the long droughts of the last years, milk quality problems as only the commercial farms have milking parlors, low average milk price at delivery to dairies, therefore it is a real milk crisis in Romania [38, 41, 46].

However, goat milk is more required grace to its special quality, and for being processed into cheese, that is why goat livestock is increasing [35].

Also, the farm structure of dairy farms is dominated by small farms where just 1-3 cows are raised, and only a few number of farms grow more than 20 or 50 cows. As it is known, farm size is deeply linked to productivity and efficiency, and the higher the number of dairy cows assures a higher production, a higher value of gross product, a higher gross margin, and profit [25, 26, 28, 30, 33, 34]. Investments in modern farms are justified and most of them are encouraged and supported by EU funds [29].

Beef is another product coming from cattle raised for meat production. However, beef is consumed just in a small proportion in Romania, only about 9 kg per capita per year, but beef is niche for export to the EU countries [43].

Pigs are traditionally reared in Romania, as pork is a traditional meat. However, swine sector is in decline due to the decreasing number of livestock, partially affected by African Swine Fever, but mainly because of the lack of piglets in the market, high input price, low price per live weight at slaughter [2, 42, 50]. Pork is also consumed in many EU countries and in the world, but the modern consumer is more and more oriented to a healthier meat with less fat and cholesterol, that is why chicken meat is on the top position [40, 51, 52].

Sheep and goats are the only species in Romania whose number was increasing during the last years because of the need of more raw milk for dairies, the special quality of goat milk and also due to the importance of sheep meat for a part of the Romanians and also for export in the Arabian countries. Also, in the mountain areas of Romania there are many sheep farms [4, 5, 45].

Poultry importance is given by the lean and tasty meat rich in high value protein and eggs which are healthy for human diet and also in the processing industry. In Romania, poultry are raised in various systems from industrialized in integrated complexes to traditional farms [22, 23, 24, 48].

General view on livestock and its distribution by individual farms and commercial companies and by size class of utilized agricultural area (UAA)

In 2016, according to National Institute of Statistics, Farm structure survey, Romania had 3,422,026 agricultural holdings, of which 2,489,459 had agricultural land and animals (72.7%) and only 79,818 holdings had only animals (23.3%).

The holdings without legal personality are numerically dominant in Romania, accounting for 99.52% of the total agricultural holdings. About 99.48% have agricultural land and animals and 99.7% farms were raising animals [21].

Most of animals are reared in individual holdings without legal personality as follows: 95.1% goats, 93.3% sheep, 86.9% bovines, 67.4% poultry and 53% pigs. In the commercial companies it is a smaller number of animals, except pigs and poultry which are suitable for industrial farming (Table 4).

Table 4. Romania's livestock by main species and main type of agricultural holding (Livestock units)

	Bovines	Pigs	Sheep	Goats	Poultry
Romania	1,584,790	991,706.2	910,653.6	137,279.2	908,839
Share of individual holdings (%)	86.9	53.0	93.3	95.1	67.4
Share of commercial companies (%)	7.4	44.4	2	1	31.7

Source: Own calculation based on the data from NIS, 2017, Farm structure survey, Romania, 2016 [21].

The highest number of holdings are raising poultry, being followed by pig farms, bovine and sheep and goat farms.

Most of agricultural holdings with animals utilizes a small agricultural area ranging between 1-5 ha. it is about 55.4% bovine farms, 48.8% sheep farms and 45.5% goats farms.

But, 45.4% of pigs farms and 53.3% poultry farms had below 1 ha UAA. Only less than 1% farm animals, except sheep farms, utilizes a higher agricultural land than 20 ha (Table 5).

The most of animals are concentrated in the smallest farms utilizing less than 5 ha. Pigs and poultry are concentrated in the smallest farms with less than 1 ha UAA: 37.1%, and, respectively, 56.3%. Also, 18.6% bovines, 18.2% sheep and 15.1% goats are concentrated in farms which utilizes 5-10 ha UAA. In 2016, the largest farms working 100 and over ha raised 8.8% bovines, 8.15 pigs, 7.2% sheep, 6.1% poultry and 20.6% goats (Table 6).

Table 5. Agricultural holdings with main animals and their distribution by size class of UAA, Romania, 2016

Agricultural holdings	Bovines	Pigs	Sheep	Goats	Poultry
	541,137	1,283,584	208,363	129,916	2,445,555
%	100.0	100.0	100.0	100.0	100.0
Below 1 ha	22.3	45.4	24.3	40.4	53.3
1-5 ha	55.4	43.9	48.8	45.5	38.8
5-10 ha	15.5	7.8	16.4	9.0	5.9
10-20 ha	4.6	2.0	6.3	3.0	1.4
20-30 ha	0.9	0.5	1.6	0.8	0.3
30-50 ha	0.5	0.2	1.1	0.6	0.2
50-100 ha	0.3	0.1	0.8	0.4	0.08
100 and over ha	0.5	0.1	0.7	0.3	0.02

Source: Own calculation based on NIS, 2017, Farm structure survey, Romania, 2016 [21**].**

Table 6. Livestock by main species and size class of UAA, Romania, 2016

Livestock (heads)	Bovines	Pigs	Sheep	Goats	Poultry
	1,849,279	4,142,785	9,106,536	1,372,792	77,195,179
%	100.0	100.0	100.0	100.0	100.0
Below 1 ha	15.8	37.1	15.0	27.4	56.3
1-5 ha	38.7	25.4	26.6	36.1	26.7
5-10 ha	18.6	6.8	18.2	15.1	5.1
10-20 ha	9.6	18.5	13.4	8.9	1.9
20-30 ha	3.1	1.3	6.2	3.6	0.6
30-50 ha	2.6	1.1	6.9	3.2	2.3
50-100 ha	2.8	1.6	6.5	3.1	1.0
100 and over ha	8.8	8.1	7.2	2.6	6.1

Source: Own calculation based on NIS, 2017, Farm structure survey, Romania, 2016 [21**].**

Farm structure and average farm size for bovine agricultural holdings

In 2016, of 541,137 agricultural holdings raising bovines, 66.1% had 1-2 animals, 29.4% had 3-9 animals, 2.9% had 10-19 heads and the remaining of about 1.6% were rearing over 20 bovines.

The number of bovines existing in 2019 in Romania accounted for 1,849,279 heads of which 27.8% were grown in farms with 1-2 heads, 37% in farms with 3-9 heads, 11.1% in farms with 10-19 heads, summing 77% and the remaining of 23% was grown in larger farms with more than 20 heads.

In Romania, 5.4% of bovines were raised in farms with 100-499 heads and 4.95 in farms with over 500 heads (Table 7).

Taking into account the number of holdings and the number of bovines, the average farm size was 3.4 heads at the country level.

The highest average accounting for 1,009 bovines was in the largest farms whose share was just almost 0.05% in the total number of holdings raising bovines. also, 0.15% of holdings had an average size of 184 bovines, and 0.2% farms raised 67.8 heads in average.

If we take into account that individual holdings are dominant representing 98.3% of total holdings with bovines and that they raised 94.9% of bovine livestock, the average size of individual holdings was 2.9 bovines, which varied, by size class of animals, from 1.4 heads in case of the smallest farms (1-2 animals) and 143 heads in case of the largest farms (100-499 heads).

The commercial companies growing bovines were just 743, representing only 0.13% of holdings with bovines, but they raised 156,729 heads, which meant 211 bovines average size per farm.

The variation of farm size by size class of animals was 1.8 heads in case of the smallest commercial companies and 1,022 bovines in case of the largest farms (Table 7).

Table 7. Number of agricultural holding raising bovines by size class of livestock and number of bovines by size class, Romania, 2016

		Size class, Bovines (heads)							
		1-2	3-9	10-19	20-29	30-49	50-99	100-499	500 and over
Agricultural holdings (No.)	541,137								
Share, %	100.0	66.1	29.4	2.9	0.8	0.4	0.2	0.15	0.05
Bovines (heads)	1,849,279								
Share, %	100.0	27.9	37.0	11.1	5.4	4.4	3.9	5.4	4.9
Average bovine farm size (heads)	3.4	1.4	4.3	13.1	23.3	37.0	67.8	184	1,009
Average bovine farm size (heads) in:									
Individual holdings	2.9	1.4	4.3	13.0	23.3	37.0	66.1	143	-
Commercial companies	211	1.8	5.5	14.0	24.5	38.1	72.2	218	1,022

Source: Own calculation based on NIS, 2017, Farm structure survey, Romania, 2016 [21].

In 2016, 472,778 agricultural holdings were raising dairy cows. About 77.2% farms had only 102 cows, 20.3% had 3-9 cows, 1.8% had 10-19 cows and the rest of 0.7% raised over 20 cows. It worth mentioning that 15 farms raised over 500 cows.

In 2016, Romania had 1,137,885 cows, of which 43.8% were raised in the smallest farms (1-2 heads), 33.6% in farms with 3-9 heads, 9.5% in farms with 10-19 cows.

Just 1.1% of dairy cows were grown in farms with more than 500 cows, 3.6% in farms with 100-499 animals, and 2.4% in farms with 50-99 cows.

In consequence, the average size for dairy farms at the national level was 2.14 heads in 2016, and it ranged between 1.4 cows in the smallest farms and 889.4 cows in the largest ones.

Due to the fact that dairy cows were bred predominantly in individual farms, the average size of dairy farms was smaller or equal in a few cases with the average registered by all the categories of holdings (Table 8).

Table 8. Number of agricultural holding with dairy cows and cow livestock by size class, Romania, 2016

		Size class, Dairy cows (heads)							
		1-2	3-9	10-19	20-29	30-49	50-99	100-499	500 and over
Agricultural holdings (No.)	472,778								
Share, %	100.0	77.3	20.3	1.8	0.34	0.2	0.09	0.04	0.03
Dairy cows (heads)	1,137,885								
Share, %	100.0	43.8	33.6	9.5	3.3	2.7	2.4	3.6	1.1
Average Dairy farm size (heads)	2.4	1.4	3.9	12.7	23.0	36.4	67.0	198	889.4
Average dairy farm size (heads) in:									
Individual holdings	2.2	1.4	3.9	12.7	23.0	36.0	65.0	139.4	-
Commercial companies	97.8	1.7	5.3	13.6	23.7	39.2	68.6	217.6	912.2

Source: Own calculation based on NIS, 2017, Farm structure survey, Romania, 2016 [21].

The commercial companies raising dairy cows had a much better average farm size, accounting for 97.8 heads, but taking into account the size class of cows, it varied between 1.7 cows for the smallest companies and 912.2 cows for the biggest ones (Table 8).

Farm structure and average farm size for agricultural pigs holdings

In 2016, Romania had 1,283,584 pigs farms, of which 86.7% were small farms (1-2 heads), 12.1% farms with 3-9 pigs, 1.1% farms with 10-49 pigs, summing 99.9%. The rest of farms were larger farms raising more than 50 pigs. A number of 133 farms raised over 1,000 pigs.

Pig livestock accounted for 4,142,785 heads in 2016, of which 35% were grown in the smallest farms (1-2 heads), 15.4% in farms with 3-9 pigs, 5.1% in farms with 10-49 heads, totaling 54.5% of the total number of pigs. The rest of pigs were raised in farms with more than 50 pigs. In 133 agricultural holdings was grown a number of 1,845,358 heads representing 44.5%.

As a result, the average farm size was 3.2 pigs, but by size class it varied between 1.3 heads in the farms with 1-2 pigs and 13,875 heads in farms raising 1,000 pigs and over.

Therefore, it was noticed a polarization of the number of pigs into two categories: 34% in the smallest farms and 44.5% in the largest ones.

Taking into account that pigs were raised in 1,274,734 individual holdings, representing 99.3% of the total number of swine farms, and that 2,234,673 pigs were bred in individual holdings accounting for 98.1% of total pig livestock, the average size of an individual holding raising pigs was 1.7 heads in the year 2016, but by size class it varied between 1.3 heads in the smallest farms and 2,000 pigs in the largest ones, which in fact were 2 holdings.

Commercial companies raising swine species accounted for 229 units where 1,804,061 animals were grown, meaning 7,878 pigs in average per farm.

The existing 15 smallest commercial societies raised 25 pigs, that is 1.7 heads per farm. But, a number of 123 commercial industrialized units raised 1,783,880 pigs, which led to the conclusion that their average size accounted for 14,503 heads per farm (Table 9).

Table 9. Number of agricultural holding with pigs and pigs livestock by size class, Romania, 2016

		Size class, Pigs (heads)							
		1-2	3-9	10-49	50-99	100-199	200-399	400-999	1,000 and over
Agricultural holdings (No.)	1,283,584								
Share, %	100.0	86.7	12.1	1.1	0.01	0.002	0.0085	0.002	0.001
Pigs livestock (heads)	4,142,785								
Share, %	100.0	34.0	15.4	5.1	0.3	0.11	0.09	0.5	44.5
Average size, Pigs farm	3.2	1.3	4.1	14.8	66.3	120.3	285.2	685	13,875
Average size of a pigs farm (heads) in:									
Individual holdings	1.7	1.3	4.1	14.7	62.7	115.5	232	-	2,000
Commercial companies	7,878	1.7	4.9	23.3	59.2	134.2	279.5	687	14,503

Source: Own calculation based on NIS, 2017, Farm structure survey, Romania, 2016 [21]

Farm structure and average farm size for agricultural sheep holdings

The number of holdings raising sheep accounted for 208,363 in the year 2016. The highest number of sheep farms accounted for 41.7% of the total units and raised 3-9 heads. About 20% of farms had 20-49 heads and 11.4% farms raised 102 sheep. Only 4.6%

farms raised between 200 and 499 sheep and 1.3% farms had 500 and over.
Sheep livestock accounted for 9,106,526 heads, of which 31.4% belonged to the farms with 200-499 heads and 23.2% were grown in the farms with more than 500 heads.
In consequence, the average farm size at the national level was 43.7 sheep, varying between 1.8 heads in the smallest farms and 810.5 heads in the biggest ones.
About 98.7% of sheep livestock was raised in 8,496,853 individual holdings, representing 95.9% of the sheep farms. As a result, the average farm size of the individual sheep farms was 41.2 heads and by size class, the average ranged between 1.8 heads in the smallest farms and 765.2 sheep in the largest ones.
Also, 190,417 sheep were raised in 202 commercial societies, meaning that the average size of such an unit accounted for 942.6 heads. However, the average by size class varied between 2 heads in the smallest commercial companies and 2,163.2 heads in the biggest ones (Table 10).

Table 10. Number of sheep agricultural holding and sheep livestock by size class, Romania, 2016

		Size class, Sheep (heads)							
		1-2	3-9	10-49	50-99	100-199	200-399	400-999	1,000 and over
Agricultural holdings (No.)	208,363								
Share, %	100.0	11.4	41.7	20.0	8.6	6.7	5.7	4.6	1.3
Sheep livestock (heads)	9,106, 526								
Share, %	100.0	0.5	5.0	5.6	5.5	10.5	18.1	31.4	23.2
Average size, Sheep farm	43.7	1.8	5.3	12.3	28.0	68.4	138.5	295.2	810.5
Average size of a sheep farm (heads) in:									
Individual holdings	41.3	1.8	5.3	12.3	28.0	68.2	138.6	295	765.2
Commercial companies	942.6	2.0	5.8	12	31.6	67.9	139.8	328	2,163.2

Source: Own calculation based on NIS, 2017, Farm structure survey, Romania, 2016 [21

Farm structure and average farm size for agricultural goats holdings
In 2016, Romania had 129,916 holdings raising goats, of which 49.9% farms had 1-2 heads and 30.4% had 3-9 heads. Only 34 farms, representing 0.2% of the total goats farms, were grown 500 goats and over.
In 2016, a number of 1,372,792 goats existed in Romania. By size class, 19.9% animals belonged to the size class 50-99 heads, 18.5% to the class 100-199 heads, 17.8% to the class 20-49 heads and 11 5 to the class 200-499 animals. Only 1.7% of the number of goats was concentrated in 34 agricultural holdings summing 23,323 heads.
In consequence, the average farm size was 10.6 goats at the national level, ranging between 1.6 heads in the smallest farms with 1-2 heads and 686 heads in the biggest farms breeding 500 goats and over.
Goats are predominantly raised in individual households and the average farm size is similar with the one of the size class 1-2 heads up to the size class 100-199 heads.
The only difference appeared in case of the largest individual holdings which had 270.9 goats in average for the size class 200-499 and 650 goats for the class 500 and over.
A number of 13,810 goats were grown in 76 commercial companies and this meant 896.3 goats per farm in average. By size class, the highest average was 896.3 goats, registered by 6 commercial units rearing 500 heads and over, and 309 goats represented the average recorded by 15 commercial companies raising 200-499 heads (Table 11).

Table 11. Number of agricultural holding with goats and goats livestock by size class, Romania, 2016

		Size class, Goats (heads)							
		1-2	3-9	10-19	20-49	50-99	100-199	200-499	500 and over
Agricultural holdings (No.)	129,916								
Share, %	100.0	49.9	30.4	8.5	6.0	3.1	1.5	0.4	0.2
Goats livestock (heads)	1,372,792								
Share, %	100.0	7.4	13.6	10.1	17.8	19.9	18.5	11.0	1.7
Average size, Goats farm	10.6	1.6	4.7	12.5	30.8	67.6	132	279.6	686
Average size of a goats farm (heads) in:									
Individual holdings	10.1	1.6	4.7	12.5	30.8	67.6	132	270.9	650
Commercial companies	181.7	-	-	12.3	32.6	71.1	147.2	309	896.3

Source: Own calculation based on NIS, 2017, Farm structure survey, Romania, 2016 [21].

Farm structure and average farm size for agricultural poultry holdings

In 2016, in Romania, there were 2,445,555 agricultural holdings raising 77,105,170 poultry.

About 99.7% of poultry farms were small farms raising 1-99 birds. The remaining were growing over 100. To specify that 0.002% of the poultry farms, more exactly 67 holdings raised 100,000 and over heads.

The number of poultry was different distributed by size class. About 57.7% poultry was in the size class 1-99 birds and at the other pole, it was the class with 100,000 heads and over, concentrating 35.3% of poultry livestock (Table 12).

Table 12. Number of agricultural holding with poultry and poultry livestock by size class, Romania, 2016

		Size class, Poultry (heads)								
		1-99	100-499	500-999	1,000-2,999	3,000-4,999	5,000-9,999	10,000-49,999	50,000-99,999	100,000 and over
Agricultural holdings (No.)	2,445,555									
Share, %	100.0	99.7	0.3	0.001	0.001	0.001	0.001	0.002	0.001	0.002
Poultry livestock (heads)	77,195,179									
Share, %	100.0	57.7	1.3	0.02	0.08	0.2	0.26	2.1	3.4	35.3
Average size, Poultry farm	31.6	18.2	131.5	644.2	1,831	3,918.7	7,076	24,274.3	71,482.5	405,828
Average size of a poultry farm (heads) in:										
Individual holdings	18.7	18.2	130.8	629	1,510	3,949	5,000	-	-	-
Commercial companies	96,009.2	30.7	156.9	830	1,979.8	3,918.6	7,059.7	24,108.3	71,482.5	410,041.33

Source: Own calculation based on NIS, 2017, Farm structure survey, Romania, 2016 [21].

In consequence, the average poultry farm size was 31.6 heads at the country level, but by size class it varied between 18.2 heads in the smallest farms raising 1-99 birds and 405,828 heads in the biggest farms with over 100,000 heads.

The average size of the individual poultry holdings accounted for 18.7 heads at the country level, by size class it ranged between 18.2 birds in case of the farms raising 1-99 heads and 5,000 birds in case of only one individual farm.

The commercial companies registered 96,009.2 birds average size, but its value varied between 30.7 birds in the smallest units and 410,041.3 birds in the companies with 100,000 heads and over, where farming process is industrialized and vertically integrated (Table 12).

CONCLUSIONS

In Romania there is a high number of animal holdings raising especially bovines, pigs, sheep and goats and poultry.

The main aspect which influences farm structure is the decline in livestock both in case of bovines, dairy cows, pigs and poultry, except sheep and goats. This trend is an advantage to increase average farm size and production efficiency.

The average farm size is very small for all the animal farms.

From the total number of agricultural holdings, 72.7% have land and animals and 23.3% are raising only animals.

Individual holdings are dominant no matter the species. In the total number of holdings, the individual holdings had the following share in the year 2016: 86.9% bovine farms, 53% pig farms, 93.3% sheep farms, 95.1% goats farms and 67.4% poultry farms.

Commercial holdings had the highest share in case of pig farms, 44.4% and poultry farms, 31.7%.

The average farm size at the national level in animal farms was the following one in the year 2016:

3.4 bovines, 2.4 dairy cows, 3.2 pigs, 43.7 sheep, 10.6 goats and 31.6 poultry.

In the individual holdings, the average farm size was the following one: 2.9 bovines, 2.2 dairy cows, 1.7 pigs, 41.3 sheep, 10.1 goats and 18.7 poultry. It is obvious that the individual farms are small scale farms.

In the commercial companies the average farm size was completely different: 211 bovines, 97.8 dairy cows, 7,878 pigs, 942.6 sheep, 181.7 goats and 96,009.2 poultry.

Therefore, farm structure does not compile with efficiency in many farms. For this reason, standard output is small in animal holdings of Romania.

The decline in livestock for bovines, pigs and poultry has led to the disappearance of a part of small farms and also due to farmers aging and their incapacity to face the market pressure.

Also, the EU funds provided by PAC have been and are of much help for creating new farms and modernize the old ones to improve farm structure and average farm size and to increase production and its effciency.

The data used in this study created an image about the situation in 2016, but for sure in the interval 2017-2021, other changes have occurred in the number of holdings, farm structure and average farm size.

It remains that a new Farm Survey and Census in 2013 to bring new data for being able to have a clear picture of the reality in animal sector regarding the approached aspects.

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CONCENTRATION OF TOURIST ARRIVALS IN TOURIST AND AGRI-TOURIST GUESTHOUSES IN THE COVID-19 PANDEMIC 2020 VERSUS 2019 IN ROMANIA

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Abstract

The paper analyzed tourist arrivals in tourist and agri-tourist guesthouses of Romania in the year 2020 compared to 2019 in order to evaluate in what measure this tourism indicator was affected by the Covid-19 pandemic. The data provided by National Institute of Statistics allow to establish the dispersion of tourist arrivals in the territory of the country by the eight microregions of development and also to quantify the levels of the specific concentration indices: Herfindahl-Hirschman Index, Gini-Struck Index and Coefficient of Concentration. After the year 2019, which reached the top arrivals, overnight stays and receipts in Romania's tourism, the year 2020 brought the Covid-19 pandemic which has disturbed tourism performance. However, in Romania the effects on tourism industry were lower than in other countries. In the periods of relaxation measures, tourists chose safe destinations for combining both the visits to objectives of high interest with tourist services of accommodation and meals at a convenient tariff. From this point of view, tourist and agri-tourist guesthouses were among the best alternatives, and they recorded a higher growth rate of tourist arrivals than at the national level in tourism industry. In 2019, tourist arrivals were higher in the tourist pensions located in the Center, North West, North East and West parts of the country, and in agri-tourist pensions situated in Center, North East, and North West. In 2020, the guesthouses situated in Centre, North West and North East regions registered the highest tourist arrivals. A moderate concentration of the arrivals was confirmed by the values of Herfindahl-Hirschman index which varied between 0.15 and 0.25, by the values of Gini-Struck index which were higher than 0.3 in the year 2019, but a little lower than 0.3 in 2020, and the values of Concentration coefficient which were higher than 0.33. Due to the reduced arrivals in 2020, all the concentration indices had lower values than in the year 2019. As final conclusion, in Romania,it is a moderate concentration of tourist arrivals, and even thou in 2020 there were problems caused by the Covid-19 pandemic, tourist and agri-tourist guesthouses were an alternative for accommodation and meals, harmoniously combining the need of safety with the desire to visit the tourist attractions of high interest.

Key words**:** *concentration, tourist arrivals, tourist guesthouses, agri-tourist guesthouses,, Romania*

INTRODUCTION

The Covid-19 pandemic has disturbed the world economy and human life, affecting in various proportions the sectors of activity and also health status and demographic indicators.
Tourism, which involves travels from home to a desired destination, has been deeply affected, as it is by its specificity a potential factor for spreading the virus. The expansion of the virus worldwide has led to travel restrictions, flights and cruises cancellations, border closure, contact restrictions (wearing the mask, keeping the social distance), strict hygiene rules, fear to leave home to avoid the risk of infection, cancellation of the cultural and sport events, closure of the restaurants and bars, tourist accommodations units or restrictions to operate at a reduced capacity, low tourist flows, overnight stays, loss of

receipts, low contribution of tourism to GDP [22, 33].

In the periods of relaxation measures taken by the authorities, tourists adapted their options regarding their vacations looking for safe destinations and also for attractions of high interest for them. In this context, rural tourism became one of the alternatives which could fulfill the travelers' desires looking for attractions far away from the crowded places, in the middle of nature for enjoying fresh air, admiring the beauty of the landscapes, for participating in recreational activities on a farm and its surroundings. In this way, rural tourism in its variants mainly ecotourism and agro-tourism has grown its importance among the tourism types.

Tourists changed their preferences regarding accommodation, and after studying the market offer, they selected in general small units mainly situated in the rural areas. In this way, tourist guesthouses and agri-tourist guesthouses have been more and more included in the list of preferences and this has influenced tourist flows to these destinations where travelers to find a good and safe accommodation and food in guesthouses which usually have a small number of rooms, traditional food, hygiene rules could be easily ensured, and also facilities for recreational activities could be provided outdoors (terraces, gardens, swimming pools, fishing, hunting, walking, biking in the surroundings etc). However, even so, the business in rural tourism has also been affected by the pandemic, but in a smaller proportion than at the level of the whole tourism industry, [29].

Internet and smart phones have become the main tools for choosing the best alternative for accommodation in tourist and agri-tourist guesthouse checking the offer on their websites, booking the period of stay, the type of the number of rooms, and even paying tourist services. Own cars have become the most preferred transportation mean especially for small distances [6]. In addition, the choice of tourist and agri-tourist guesthouses was a good alternative especially for the tourists with reduced income, due to the closure for a period of time of the enterprises where they worked, passing to online work or due to the loss of their job, which diminished the budget allotted for spending the vacations and, of course, a cheaper accommodation has become more attractive. This has led to the decline in the number of arrivals, overnight stays, to the reduction of the personnel and turnover in tourism industry [1]. In Romania, rural tourism plays a more and more important role in tourism and travel industry and the sustainable development of various regions and settlements [2, 4].

Rural tourism development has been sustained by the increased demand to which offer has been obliged to give a feed-back in terms of the number of tourist and agri-tourist guesthouses, number of rooms and beds, comfort conditions, alternatives for recreational activities, traditional architectural style, natural decorations, traditional food, special offers for various feasts (Easter, Christmas and New Year's Eve etc) [16, 17].

The number of places increased, and the variety of facilities as well, as it is proved by the existence of a positive and strong correlation between tourist arrivals and accommodation capacity and also between the number of overnight stays and tourism receipts, and tourism contribution to GDP [14, 18, 25, 26]. In this context, the purpose of the paper was to study the number of arrivals in tourist and agri-tourist guesthouses at national level and by the eight micro regions of development and assess the concentration degree using the specific indicators: Herfindahl-Hirschman Index, Gini-Struck Index and Concentration Coefficient in the Covid-19 pandemic of the year 2020 in comparison with tourist arrivals in 2019.

In this way, it is possible to quantify the impact of the pandemic on tourist flows and in what measure tourists preferred tourist and agri-tourists guesthouses exiting on the territory in various regions of development of Romania.

MATERIALS AND METHODS

The study is based on the available data on the website of the National Institute of Statistics, Tempo Online data base for the years 2019 and 2020. The number of arrivals was studied both at the national level and by type of guesthouse: tourist and, respectively, agri-tourist pension, and also in the territory by the eight microregions of development: North West, Center, North East, South East, South Muntenia, Bucharest Ilfov, South West Oltenia and West.

The data were processed using the following procedures:

-*Fixed index*, $I_{FB(\%)} = (X_{2020}/X_{2019}) \times 100$, where: X is the variable representing tourist arrivals.

-*Structural index*, $S_{\%}$, was used for showing the dispersion of tourist arrivals by microregion.

-*Comparison method* allowed a spatial evaluation in the two years and the changes in time, from a year to another.

-*Herfindahl-Hirschman Index, HHI_j*, was determined using its known formula:

$$HHI_j = \sum_{i=1}^{n} g_{ij}^2 \qquad (1)$$

where: g_{ij}^2 is the square share of the arrivals in each microregion in the total number of tourist arrivals in Romania, and n is the number of microregions.

-*Gini-Struck Index, GS,* was calculated according to the formula:

$$GSC_j = \sqrt{\frac{n\sum_{i=1}^{n} g_i^2 - 1}{n-1}} \qquad (2)$$

-*Concentration Coefficient, CC_j*, was established using the formula:

$$CC_j = \frac{n}{n-1} GSC_j \qquad (3)$$

The results were tabled and interpreted, and finally the main conclusions were drawn.

RESULTS AND DISCUSSIONS

General overview of tourist arrivals in Romania and tourist and agri-tourist guesthouses

In Romania, during the Covid-19 pandemic of the year 2020, tourist traffic was disturbed registering a decline in tourist arrivals, which represented about 47% of the 13,374,943 tourist arrivals in 2019 [22].

Tourist flows were focused in general to mountain and seaside destinations [23], but also to the regions well known for their tourist attractions like Central and South Transilvania [12] for example: Cluj [28], Mures [11], Brasov [7, 10], Sibiu [31], Maramures [27] and Bucovina [13].etc.

As usual, the Romanian tourists were dominant in the tourist flow, in 2020 having a share of 92.9% in total arrivals, by +16.22 pp higher than in the year 2019.

In the year 2020, a number of 654,397 tourists applied for accommodation in tourist guesthouses, representing 52.16% of the 2019 level, while 755,435 tourists preferred accommodation in agri-tourist guesthouses, accounting for 59.34% of the level registered in the previous year.

In 2020 versus 2019, the arrivals of the Romanian tourists increased by +7.02 pp in tourist pensions and by + 6.6 pp in agri-tourist pensions.

The share of the tourists preferring accommodation in tourist pensions increased from 9.37% in 2019 to 10.22% in 2020, while the weight of tourists applying for accommodation in the agri-tourist guesthouses increased from 9.51% to 11.80% (Table 1).

The results presented in Table 1 showed that the decline in tourist arrivals was stronger at the national level, but in case of guesthouses, tourist traffic was relatively less affected by the pandemic. This is a sign which emphasizes a change in tourists' preference to a safe places where to rest, eat and benefit of leisure during holidays, as guesthouses are located in general outside of the large cities, in smaller localities or in the middle of nature, have a smaller number of rooms than a hotel, tourist traffic is lower, they could be hired by a family or a group of friends, and the tariff is lower than in a hotel.

Table 1. Number of tourist arrivals in Romania and in tourist and agri-tourist guesthouses in the year 2020 versus 2019

	Tourist arrivals (1,000)			of which Romanians (1,000)			% of Romanians in total arrivals	
	2019	2020	2020/ 2019 %	2019	2020	2020/ 2019 %	2019	2020
Arrivals in Romania	13,375	26,399	47.8	10,691	5,9445	55.6	79.93	92.90
-In Tourist pensions	1,254	654	52.16	1,134	637	56.18	90.30	97.32
-In Agri-tourist pensions	1,273	755	59.34	1,172	745	63.62	92.0	98.6
Share of arrivals in tourist pensions %	9.37	10.22	-	10.60	10.71	-	-	-
Share of arrivals in agri-tourist pensions	9.51	11.80	-	10.96	12.54	-	-	-

Source: Own calculation based on the date from NIS, 2021 [9].

Therefore, tourists' criteria to choose a place for accommodation during their vacation in the pandemic were to be far away from the crowded cities, to offer a safe vacation, to offer traditional food, and also the ensure the joy of being a longer time outdoors in the middle of nature.

These criteria are justified by the high number of tourist and agri-tourist guesthouses which have appeared on the map of Romania in various regions during the last decades, as small family business in tourism was encouraged to valorize the local natural, material, human, cultural and historical resources in order to contribute to the economic and social development of the localities and regions and to bring additional income for the rural population and farmers and improve their living standard. The EU funds offered an important financial support for the implementation of the programmes destined to sustain the development of the rural tourism [8, 24].

The accommodation capacity in guesthouses has increased with a higher growth rate regarding both the number of units and beds, compared to the growth rate at the national level in tourism industry. As the rural population represents a high share of about 44% in Romania's population, the development of rural tourism has been encouraged by the small and family business valorizing the initiatives of local population to provide high quality products and services [4, 5, 19].

In addition, the local traditions (folklore music, dance, suits, handicrafts, gastronomy etc) specific in various regions and mainly in the rural areas of Romania are other key points of attraction for tourists and contribute to the increase of the importance of rural tourism and especially of agri-tourism [3].

Tourist arrivals in tourist and agri-tourist guesthouses by microregions of Romania

Tourist arrivals in tourist pensions

In 2019, the distribution of tourist arrivals in tourist pensions by microregion, in the decreasing order was: Center, North West, North East and West, regions which absorbed 79.13% of the total arrivals in tourist pensions. Lower percentages were recorded by South Muntenia, South West Oltenia, South East and Bucharest Ilfov microregions.

In 2020, the decreasing order of the weights of arrivals in microregions in total tourist arrivals in tourist pensions was: Centre, North East, North West, West, and finally South Muntenia, South West Oltenia, South East and Bucharest Ilfov.

The change in the shares of tourist arrivals by microregion reflected tourists' desire to choose accommodation in tourist pensions situated in the regions where the degree of infection with Covid-19 was lower and among the lowest, where the restrictions were more relaxed, the stay during the vacation to be safe and the tourist pensions to be closer to the main attractions which deserve to be visited (Table 2 and Fig. 1).

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Table 2. Tourist arrivals in tourist guesthouses by microregion in 2020 versus 2019

	Tourist arrivals (1,000)			Share by microregion (%)		Difference 2020-2019 pp
	2019	2020	2020/2019 %	2019	2020	
North West	186	87	46.98	14.82	13.35	-1.47
Center	470	235	50.00	37.46	35.91	-1.55
North East	182	103	56.95	14.47	15.80	+1.33
South East	45	25	57.00	3,57	3.90	+0.33
South Muntenia	109	59	54.30	8.70	9.05	+0.35
Bucharest Ilfov	21	10	45.69	1.69	1.48	-0.29
South West Oltenia	87	52	60.28	6.91	7.99	+1.08
West	155	82	52.75	12.38	12.52	+0.14

Source: Own calculation based on the date from NIS, 2021 [9].

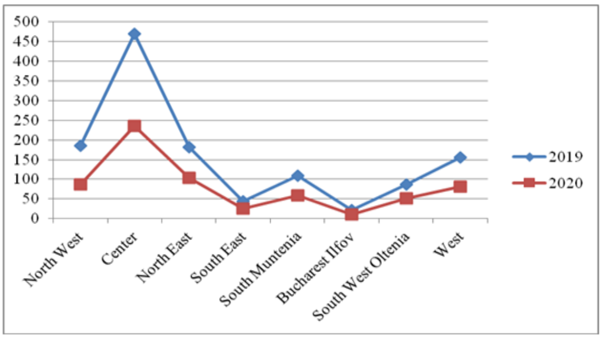

Fig. 1. Tourist arrivals in tourist guesthouses by microregion in 2020 versus 2019 (Thousands)
Source: Own design based on NIS data, 2021 [9].

Tourist arrivals in agri-tourist pensions

In 2019, the distribution of tourist arrivals in agri-tourist guesthouses by microregion, in the descending order was the following one: Center, North West, North East, all these three microregions summing 71.89% of the total arrivals in this type of accommodation units. The other microregions had lower percentages and in the descending order they were: South Muntenia, South East, South West Oltenia, West, South East and Bucharest Ilfov.

In 2020, the weight of tourist arrivals in agri-tourist pensions by microregion was, in the decreasing order: Center, North West and North East, summing 70.17%, while the order of the other microregions was South West Oltenia, South East, West, South Muntenia and Bucharest Ilfov (Table 3 and Fig. 2).

Therefore, there were noticed important changes in the distribution of tourist arrivals in the South part of Romania including the last microregions mentioned in Table 3.

In the pandemic year 2020 versus 2019, the share of arrivals in agri-tourist guesthouses by microregion registered the highest increase of +2.43 pp in South West Oltenia, a moderate increase of +0.76 pp in South East, of +0.65 pp in North East, and the smallest growth of +0.03 pp in the West microregion.

Table 3. Tourist arrivals in agri-tourist guesthouses by microregion in 2020 versus 2019

	Tourist arrivals (1,000)			Share by microregion (%)		Difference 2020-2019 pp
	2019	2020	2020/2019 %	2019	2020	
North West	260	144	55.29	20.43	19.03	-1.40
Center	432	249	57.64	33.95	32.98	-0.97
North East	223	137	61.55	17.51	18.16	+0.65
South East	83	55	66.29	6.52	7.28	+0.76
South Muntenia	96	46	48.23	7.52	6.11	-1.41
Bucharest Ilfov	4	2	44.16	0.35	0.26	-0.09
South West Oltenia	93	73	79.13	7.29	9.72	+2.43
West	81	49	59.57	6.43	6.46	+0.03

Source: Own calculation based on the date from NIS, 2021 [9].

In the other microregions, the changes of the share had a negative sign as follows: -1.41 pp in South Muntenia, -1.40 in North West, -0.97 pp in the Center, and -0.09 pp in Bucharest Ilfov. A first conclusion, comparing the shares of tourist arrivals by microregion and by type of guesthouse is that most of the arrivals were concentrated both in tourist and agri-tourist guesthouses situated in the following microregions: Center, North West and North East.

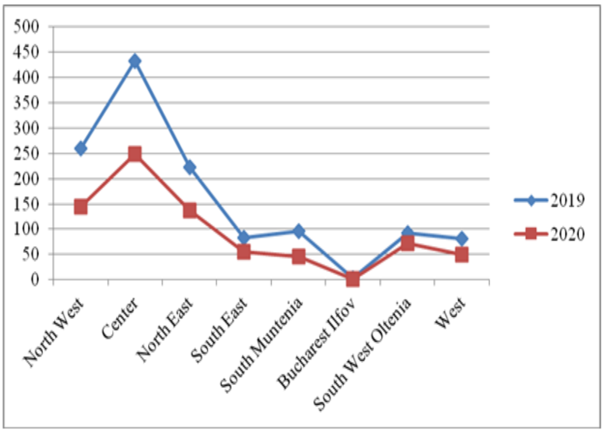

Fig. 2. Tourist arrivals in agri-tourist guesthouses by microregion in 2020 versus 2019 (Thousands)
Source: Own design based on NIS data, 2021 [9].

The shares of the arrivals in tourist pensions cumulated in these three regions accounted for 66.75% in 2019 and 65.06% in 2020, while in case of agri-tourist pensions, they summed 71.89% in 2019 and 70.17% in 2020. This unequal dispersion of arrivals among microregions was determined by many factors, among which we specify: the safety of the destination, tourist attractions and the preference for having accommodation and food in the same place.

Therefore, the pandemic determined a new orientation of the tourists to the rural areas of various regions which have become of high attraction in Romania.

A similar trend was noticed in other countries, like in Portugal and Czechia [30, 32].

Concentration of tourist arrivals in guesthouses in terms of the specific indicators

In general, in Romania, tourist arrivals had a moderate concentration in the territory by microregion of development, closely related to the distribution of tourist attractions on the map of the country [15]. A few studies, made in the previous years, proved that there is a moderate concentration in agri-tourism and also in the Central part of Romania, represented by Transilvania region which is well-known for its medieval cities, castles, fortified churches and other objectives of high interest for tourists [20, 21]. In our study, the obtained results are presented below**.**

Herfindahl-Hirschman Index registered the value 0.212 in the year 2019 and 0.2033 in 2020, that is a decline by -0.0087 for arrivals in tourist guesthouses. The values varying between 0.15 and 0.25 reflected a moderate concentration of tourist arrivals. In case of the arrivals in agri-tourist pensions, Herfindahl-Hirschman Index had lower values as follows: 0.2067 in the year 2019 and 0.2002 in 2020, which means a decline of -0.0065, and also reflected a moderate concentration.

Gini Struck Index had a higher value than 0.3 in the year 2019, both in case of arrivals in tourist and agri-tourist pensions.

This reflected a relative concentration of tourist arrivals. In the year 2020, the value of Gini Struck Index was smaller than in the year 2019, GS = 0.2991 for tourist arrivals in tourist pensions and GS = 0.2931 for agri-tourist pensions. As long as the values are lower than 0.3, this means that it is a low concentration of arrivals in the two types of pensions.

Coefficient of Concentration had higher values than 0.3 which reflected a relative concentration of the arrivals both in 2019 and 2020 in the two types of guesthouses. However, in 2019, the Concentration Coefficient registered higher values than in 2020 in the both cases (Table 4, Fig. 3 and Fig. 4).

Table 4. The values of Herfindahl-Hirschman Index, Gini-Struck Index and Concentration Coefficient of the arrivals in the tourist and agri-tourist guesthouses in Romania in 2020 versus 2019

	Tourist arrivals in tourist guesthouses		Tourist arrivals in agri-tourist guesthouses	
	2019	2020	2019	2020
Herfindahl-Hirschman Index	0.2120	0.2033	0.2067	0.2002
Gini-Struck Index	0.3153	0.2991	0.3055	0.2931
Concentration Coefficient	0.3603	0.3418	0.3491	0.3349

Source: Own calculation.

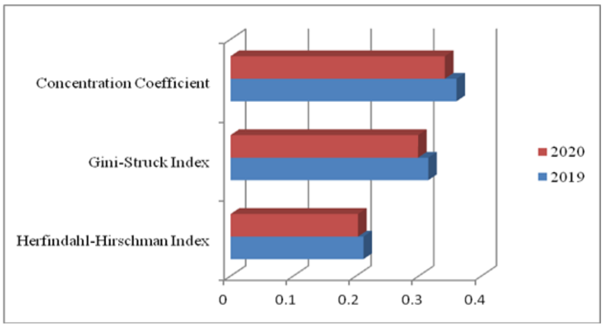

Fig. 3. Concentration indices of tourist arrivals in tourist guesthouses in 2019 and 2020
Source: Own design and calculation.

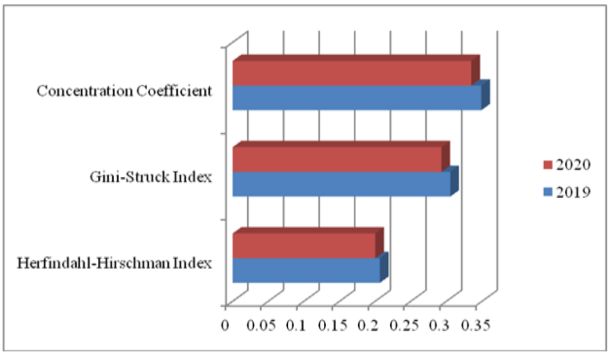

Fig. 4. Concentration indices of tourist arrivals in agri-tourist guesthouses in 2019 and 2020
Source: Own design and calculation.

CONCLUSIONS

In 2020, the Covid-19 pandemic affected tourism both at the national and local level, the number of arrivals being lower than in the year 2019, which was the year with the top performance in terms of arrivals and receipts.
However, in Romania the effects on tourism industry were lower than in other countries.
Tourist and agri-tourist guesthouses were alternatives chosen by tourists for accommodation, food and leisure, due to the advantage of being a safer place, with low infection risk, situated in the proximity of the attractions of interest for tourists, offering good quality services connected to a more convenient price.

The number of tourists arrivals in guesthouses registered a higher growth rate than at the national level. Also, it was noticed that the number of arrivals was higher in agri-tourist guesthouses than in tourist pensions.
In 2019, by microregion, the highest tourist flows to tourist pensions was registered in the Center of Romania, in the North West, North East and the West part of the country, while in the agri-tourist guesthouses the most numerous arrivals were oriented to the Center, North East, and North West.
In 2020, most of the tourists stayed in the tourist guesthouses located in the Centre, North West and North East regions, and in the agri-tourist guesthouses situated in the Center, North West, North East and in a smaller proportion in South West Oltenia.
The concentration indicators: Herfindahl-Hirschman index, Gini-Struck Index and Concentration coefficient have pointed out a moderate concentration. The values of Herfindahl-Hirschman index varied between 0.15 and 0.25, the values of Gini-Struck index was over 0.3 in the year 2019 and in 2020 registered a slight decline, and the coefficient of concentration recorded values which ranged between 0.3418 and 0.3349 in the pandemic of 2020.
As a remark, in 2019, all the concentration indicators had higher values than in the year 2020.

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THE USE OF CHEMICAL FERTILIZERS IN ROMANIA'S AGRICULTURE

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Abstract

The paper analyzed the evolution of the surfaces where chemical fertilizers were used, total consumption of fertilizers and the average consumption per surface unit in Romania and also by micro-region of development in order to establish the trends in the use of the fertilizers, and its concentration degree in terms of Herfindahl-Hirschman Index, (HHI), Gini-Struck Index (GSI) and Coefficient of Concentration (CC). The empirical data were collected from National Institute of Statistics for the period 2007-2020. Romania's mineral fertilizer consumption accounts for 5% of the EU total consumption, for which the country is ranked the 7th after France, Germany, Poland, Spain, United Kingdom and Italy. Compared to the EU mean of 77.2 kg Nitrogen fertilizer consumed per ha UAA in the year 2018, Romania applied less than 60 kg, a level which is far away from over 100 kg used by Belgium, Netherlands, Czechia and Denmark. In 2020, the average consumption of mineral fertilizer in Romania reached 98.16 kg/ha, which is still lower than in the Western EU countries. In the year 2020, the average consumption in Romania was exceeded, in the descending order, only by the West, Bucharest-Ilfov, North West and South West Oltenia regions. If in 2007, it was observed an uniform consumption of fertilizers among the eight micro-regions of Romania, in 2020, a slight moderate concentration was noticed in terms of HHI, GSI and CC. The regions with the highest share in mineral fertilizer consumption in Romania, in the decreasing order, are: West, South Muntenia, South West Oltenia, North East, South East and North West regions. The EU policy regarding the sustainable development of agriculture reducing the use of chemical fertilizers for protecting environment, biodiversity and ensuring food safety is welcome, but it has to be adapted to the actual average consumption and also taking into account the local needs of each country regarding the growth of productivity, farmers' income and profit.

Key words: *chemical fertilizers, consumption, dynamics, regional utilization, Romania*

INTRODUCTION

If the forecast for the globe population is 9.1 Billion inhabitants by 2050, then food production should grow by 70% as estimated by FAO [1].
As long as the globe has a limited agricultural area, farmers have to use modern technologies for producing more food to cover the population's needs.
Chemical fertilizers are a crucial farm input for increasing productivity in conventional agricultural system, but with a negative impact on environment. However, the role of chemical fertilizers must not be denied, because they are a source of nutrients for soil besides oxygen, hydrogen and water [11].
Plants need various nutrients along the growth phases in order to achieve quantitative and qualitative productions and expected productivity per surface unit. For this reason, in conventional agriculture there are used many types of chemical fertilizers, of which: the ones based on Nitrogen, Phosphorus and Potassium are of the highest importance, being followed by other fertilizers which have in their composition other minerals [9].
The Nitrogen-based fertilizer is the most used worldwide as it provides a good plant development, a high resistance to diseases and

pests, a high productivity per surface unit and products of good quality. A similar impact has the use of Phosphate and Potash, which multiply the Nitrogen effect in stimulating photosynthesis, plant metabolism, favouring the growth of roots, flowers, seeds, fruits, water movement into the plant and a high production level [4].

The highest amount of fertilizers is requested by cereals, especially wheat, maize, rice and also oilseed crops [2, 10, 13, 15, 25].

But, a high applied amount of fertilizer could affect soil and water quality due to the spread of minerals. Therefore, the use of chemical fertilizer has become a controversial topic nowadays, because it could increase pollution, affects biodiversity and even human health.

For this reason, the use of chemical fertilizer has to be kept under control, and conventional system of agriculture is more and more in competition with organic agriculture which is an "open door" for ensuring a healthier diet and maintaining life on the Earth.

Farmers have to become more conscious that the applied amount of fertilizer has to be optimized in accordance with the need of nutrients by plants and the reserve of nutrients existing in the soil. The dose of fertilizer per surface unit depends on large range of factors, such as: plant type, its requirements to grow, the reserve of minerals in the soil, the capacity of some plants to produce and fix Nitrogen, expected yield, applied technologies (crop variety and hybrids, soil tillage, forecrop etc), existence or lack of irrigation systems, climate factors etc. [14, 16].

At the global level, the consumption of chemical fertilizer per surface unit varies from a country to another, from zero to more than 200 kg, but the diminishing trend is imposed of the need to protect environment factors and human life [12].

Romania is a special case in among the EU member states due to its peculiarities regarding the huge number of agricultural holdings, small sized farms, low yields in general, and the dominant family farming.

Agricultural output achieved by Romania accounted for Euro 15,290 Million, of which 70.8% crop output [7].

This reflects that agriculture is an important branch of the economy which gives its contribution to GDP and ensure the internal market and export with food products of good quality. It also absorbs an important part of labour force, agriculture being the main occupation and income source for the population living in the rural areas [19, 22, 23].

The area of arable land and permanent crops is 9.9 million ha, but in the country there are also 4.9 million ha grasslands. The companies practicing conventional agriculture represent below 1% of the total number of farms, but they work about 46% agricultural land.

Main agricultural crops cultivated in Romania are cereals (maize, wheat, barley), oilseeds crops (sunflower, rape, soybean), vegetables (tomatoes, cucumbers egg plants), potatoes, grapes etc. [18, 20, 21].

A high amount of fertilizers is requested by wheat, maize, sunflower, soybean, vegetables etc. [3].

In this context, the purpose of the paper was to analyze the dynamics of the surfaces where chemical fertilizers were applied, total consumption of fertilizers and the average consumption per surface unit both at the national level and in the territory by micro-region of development in order to establish the trends in the use of the fertilizers, and in the concentration degree.

MATERIALS AND METHODS

This research claimed empirical data which have been collected from National Institute of Statistics, Tempo Online data base for the period 2007-2020.

The main indicators used to characterize the use of the chemical fertilizer were: the area on which fertilizers were applied, the total amount of used fertilizer, the quantity of fertilizer used per surface unit. The tendencies both at the national level and in the territory by micro-region were emphasized, and also were identified the areas where chemical fertilizers are used in the highest amount.

Polynomial equations were used to reflect the trend line of the indicators along the chronological series.

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For assessing the degree of concentration of the use of fertilizers, there were determined the values of the well known concentration indices: Herfindahl-Hirschman Index, Gini-Struck Index and the Coefficient of Concentration.

Comparisons were made by region of development based on the absolute values of the indicators and also on their shares.

The processed data were synthetically presented in tables and the graphics allowed to illustrate the evolution of the chosen indicators.

At the end of the paper, there were exposed the main ideas resulting from this statistical research.

RESULTS AND DISCUSSIONS

The agricultural area where chemical fertilizers were applied in Romania increased by 17.11% after the country adhesion to the EU. If in 2007, 6,423 thousand ha were fertilized, in the year 2020, the surface reached 7,522 thousand ha, representing 51.5% of the 14.6 million ha agricultural area and 80.8% of the 9.39 million ha arable land (Fig. 1).

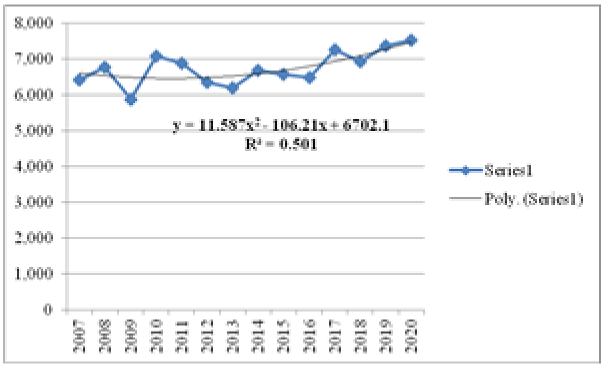

Fig. 1. Dynamics of the agricultural area where the chemical fertilizers were used in Romania, 2007-2020 (Thousand ha)
Source: Own calculation and design based on NIS data, 2021 [17].

The total amount of chemical fertilizer utilized in the country raised by 90.69% from 387 thousand tons active substance (a.s.) in the year 2007 to 738 thousand tons a.s. in the year 2020, reflecting the interest of the farmers to sustain yield performance (Fig. 2).

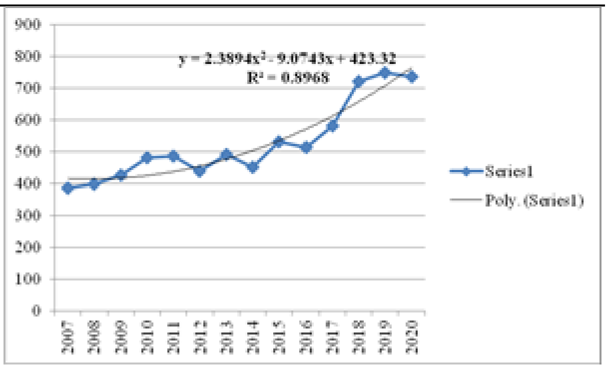

Fig. 2. Dynamics of the total amount of chemical fertilizers used in Romania, 2007-2020 (Thousand tons 100% active substance)
Source: Own calculation and design based on NIS data, 2021 [17].

The amount of chemical fertilizer utilized per ha also recorded an increase by +63.33% from 60 kg a.s./ha in 2007 to 98 ka a.s./ha in 2020. This was a consequence of the growth both in the area where the fertilizers were applied and the quantity used (Fig. 3).

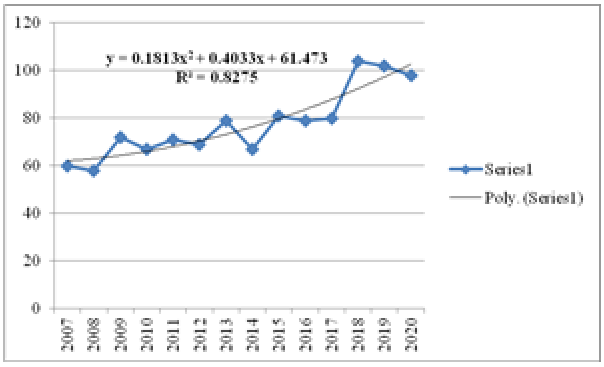

Fig. 3. Dynamics of the quantity chemical fertilizers applied per surface unit in Romania, 2007-2020 (kg a.s./ha)
Source: Own calculation and design based on NIS data, 2021 [17].

Among chemical fertilizers, the most important group used in Romania is based on NPK, of which Nitrogen-based one is consumed in the highest proportion because of the crop structure and expected yields.

In the year 2009, the EU average consumption of manufactured NPK fertilizers was 76 kg nutrients per ha UAA, of which 59 kg Nitrogen, 6 kg Phosphorus and 11 kg Potassium.

Romania had the lowest average consumption of NPK fertilizer accounting for 35 kg, of which 21 kg Nitrogen, 2 kg Phosphorus and 2 kg Potassium per ha UAA. Therefore, the average consumption in Romania represented 46% of the EU mean [5].

In 2019, according to Eurostat, Romania consumed 456 thousand tons Nitrogen-based fertilizer, coming on the 6th position after France, Germany, United Kingdom, Spain and Poland [8].

In 2018, in the EU-28, it was consumed 10,1691 thousand tons Nitrogen fertilizer, of which France 21%, Germany 14.7%, Poland 11.5%, Spain 10.1%, United Kingdom 10.1%, Italy 5.2% and Romania 4.6%, the last coming on the 7th position.

The average N fertilizer consumption at the EU level was 77.2 kg/UAA, ranging between the lowest level reached in Romania, being below 60 kg/ha and the highest level of over 100 kg in Belgium, Netherlands, Czechia and Denmark. Therefore, Romania has a lower consumption of Nitrogen fertilizer per surface unit than the EU mean and if we compare the figures for the consumption practiced by the farmers from Belgium, Netherlands, Czechia and Denmark which apply over 100 kg/ha, we may affirm that Romania consume by 50% less N fertilizer than the top EU member states regarding this indicator [6].

Romania is also far away from the world average consumption of Nitrogen fertilizer which in the year 2018 accounted for about 200 kg/ha, and for this reason, the country is placed on the 105 position at the global level [24].

The use of chemical fertilizer in the territory of Romania by micro-region of development

Regarding the dispersion of the surfaces where chemical fertilizers are applied at the regional level, we may affirm that it is closely linked to soil fertility, crop structure, yield level, applied technologies, farms size, farmers' financial resources etc.

From an empirical point of view, in the year 2007, the largest surfaces chemically fertilized were in South Muntenia (19.3%), West (15.5%), North West (15.1%), North East (14.6%0, South East (13.1%) and South West Oltenia (12.9%), all these regions together summing 71.46% of the 6,422,910 ha where mineral fertilizers were utilized. The application of this sort of fertilizers but on smaller surfaces was practiced in the Central part of the country and in Bucharest-Ilfov area.

Table 1. Distribution of chemical fertilization in the territory of Romania by micro-regions of development, 2007-2020

	Fertilized surface (Thousand ha)		Amount of fertilizer used (Tons a.s)		Amount of fertilizer applied per surface unit (kg a.s./ha)		Absolute difference, 2020-2007 (kg a.s./ha)
	2007	2020	2007	2020	2007	2020	
Total Romania	6,422.9	7,522.2	387,216	738,453	60.28	98.16	+37.88
Share of the micro-region in the country level (%)							
North West	15.17	9.52	12.92	10.74	51.32	110.76	+59.44
Center	7.65	9.01	9.16	7.34	72.19	79.96	+7.77
North East	14.63	15.46	13.56	13.72	55.86	87.23	+31.37
South East	13.17	13.27	12.78	11.28	58.66	83.42	+24.76
South Muntenia	19.37	21.15	20.73	17.63	64.51	81.84	+17.33
Bucharest Ilfov	1.52	0.67	1.09	0.86	43.18	127.27	+84.09
South West Oltenia	12.97	15.86	12.62	17.11	58.62	105.98	+47.36
West	15.56	15.60	17.14	21.32	66.51	138.75	+72.24

Source: Own calculation based on NIS data, 2021 [17].

In the year 2020, it was registered an increase of the fertilized surface in the Central region, North East, South East, South Muntenia, South West Oltenia and West, while in North

West and Bucharest Ilfov, it was noticed a decline.

Also, in 2020, it was observed a slight concentration of the fertilized land in the following micro-regions; South Muntenia (21.1%), South West Oltenia (15.8%), West 915.6%), North East (15.4%) and South East (13.2%), accounting for a total of 81.34% of the 7,522,224 ha area where the mineral fertilizers were utilized at the country level (Table 1).

Of the total amount of chemical fertilizers used in Romania in 2007, accounting for 387,216 tons a.s., the highest quantity was applied in the following micro-regions; South Muntenia (20.7%), West (17.1%), North East (13.5%), North West (12.9%), South East (12.7%) and South West Oltenia (12.6%), summing 89.75%.

In the Central region and Bucharest Ilfov, it was used the smallest amount of fertilizer. In the year 2020, of the amount of 738,453 tons a.s. mineral fertilizers, in the territory, its consumption was as follows: the regions with the highest shares in the total consumption, in the descending order, were: West (21.3%), South Muntenia (17.6%), South West Oltenia 917.1%), North East (13.7%), South East (11.2%) and North West (10.7%), totalling 91.8%, and the remaining amount was used in the Central and Bucharest-Ilfov zones (Table 1).

The average quantity of mineral fertilizer applied in Romania was 60.28 kg a.s./ha, with variations from a region to another. The largest amount of fertilizer/ha was applied in the Central area (72.19 kg), followed by West area (66.51 kg), South Muntenia (64.51 kg), South East (58.66 kg), South West Oltenia (58.62 kg), North East (55.86 kg), and North West (51.32 kg) and, the lowest amount was utilized in Bucharest-Ilfov zone (43.18 kg).

Therefore, the Central region, West, South Muntenia exceeded the average consumption per ha, while South East, South West Oltenia, and North East areas utilized a lower amount than the country mean, while North West and mainly Bucharest Ilfov consumed much smaller quantities. In the year 2020, at the national level, the mean consumption of chemical fertilizers reached 98.16 kg a.s./ha, a level which was exceeded only in the West region (138.75 kg), Bucharest-Ilfov (127.27 kg), North West area (110.76 kg), South West Oltenia (105.98 kg). In the other micro-regions, the fertilization level was smaller than the country mean. In the Central part, it accounted for only 79.96 kg/ha (Table 1).

Of course, in the consumption structure, the Nitrogen-based fertilizer is the most required, followed by Phosphorus and Potassium. However, regarding the consumption in the EU countries, in Romania the level is much smaller, because chemical fertilization is made mainly by the commercial agricultural holdings which have financial resources, taking into account the price of mineral fertilizer which increased year by year. In the small holdings, natural fertilizer is usually utilized.

The degree of the concentration of chemical fertilization in Romania

The calculated values for the concentration indices were small in general and varied in limited thresholds from 2007 to the year 2020. *Herfindahl-Hirschman Index (HHI)* had a smaller value than 0.15 in the year 2007 both for the fertilized surface and the quantity applied, reflecting that in Romania it was a relatively uniform distribution among micro-regions.

Table 2. Values of the concentration indices for the fertilized surface and amount of used chemical fertilizer in the year 2020 compared to the year 2007

	Fertilized surface		Fertilizer amount applied	
	2007	2020	2007	2020
Herfindahl-Hirschman Index	0.1461	0.1527	0.1477	0.1539
Gini-Struck Index	0.1552	0.1779	0.1610	0.1817
Concentration coefficient	0.1773	0.2033	0.1839	0.2076

Source: Own calculation.

In the year 2020, the values of HHI increased, ranging between 0.15 and 0.25, but being much closer to 0.15, they reflected a slight moderate concentration both regarding the fertilized surface and the amount applied (Table 2, Fig. 4).

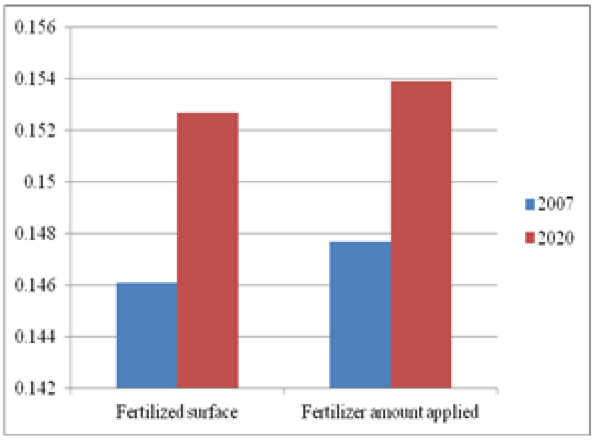

Fig. 4. Evolution of concentration degree of fertilization in Romania in terms of Herfindahl-Hirschman Index
Source: Own calculation and design.

Gini-Struck Index reflected a similar situation, the agricultural surfaces looked to be uniformly fertilized in the territory, without substantial gaps among micro-regions of development. Therefore, we did not notice any spot of concentration in 2007. But, in the year 2020, it appeared a slight tendency of concentration both in case of the fertilized areas and the quantity of utilized fertilizer.

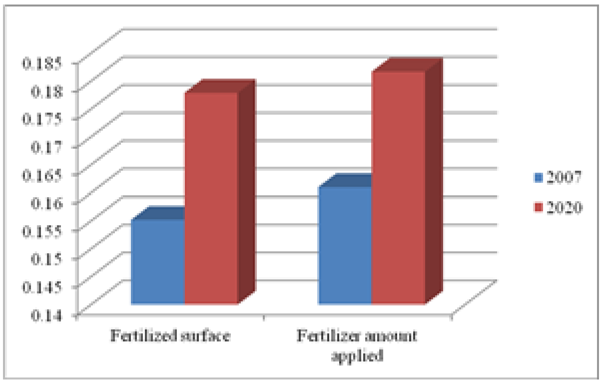

Fig. 5. Evolution of concentration degree of fertilization in Romania in terms of Gini-Struck Index
Source: Own calculation and design.

The values of GSI were higher in 2020 than in 2007 and varied between 0.1552 and 0.1779 for the surface where the chemical fertilizers were applied and 0.1610 and 0.1817 in case of the amount of used fertilizer (Table 2 and Fig. 5).

The Concentration Coefficient registered values below 0.3 both in the year 2007 and in 2020, which reflects a lack of concentration in the first year of the analysis and a slight moderate concentration in the last year, both for the fertilized land and the applied amount of fertilizer (Table 2 and Fig. 6).

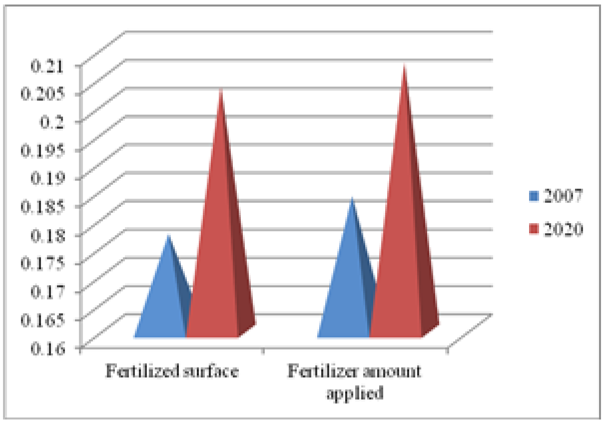

Fig. 6. Evolution of concentration degree of fertilization in Romania in terms of Concentration Coefficient
Source: Own calculation and design.

CONCLUSIONS

Chemical fertilization is still important for Romania's agriculture because the yield level is lower than in other EU countries, and for increasing productivity, income and profit, the farmers practicing conventional agriculture needs to acquire fertilizers besides other farm inputs like certified seed, fuel, pesticides etc.
In 2018, Romania's consumption of mineral fertilizer represented about 5% of the EU total consumption, for which the country is situated on the 7th position after France, Germany, Poland, Spain, United Kingdom and Italy.
In 2018, compared to the EU average consumption of Nitrogen based fertilizer accounting for 77.2 kg per ha UAA, Romania consumed less than 60 kg/ha UAA, being situated on the last position. More than this, Romania is far away from Belgium, Netherlands, Czechia and Denmark which consume more than 100 kg Nitrogen fertilizer per ha UAA,
In 2020, the consumption of mineral fertilizer in Romania accounted for 98.16 kg/ha.

Therefore, Romania has a lower consumption of Nitrogen fertilizer per surface unit than the EU mean and if we compare the figures for the consumption practiced by the farmers in the Western countries, we may affirm that Romania consume by 50% less N fertilizer than the top EU member states regarding this indicator.

In the year 2020, in the territory of Romania the average consumption of chemical fertilizers of 98.16 kg a.s./ha was exceeded, in the descending order, by the West, Bucharest-Ilfov, North West and South West Oltenia regions.

The analysis made in the territory proved that, a slight moderate concentration was noticed in terms of Herfindahl-Hirschman Index, Gini-Struck Index and Concentration coefficient in the year 2020 compared to the year 2007. Therefore, there are a few micro-regions of development were the consumption of fertilizer is a little higher than in other areas. In 2020, about 91.8% of the total consumption of manufactured fertilizer was utilized by West, South Muntenia, South West Oltenia, North East, South East and North West regions.

The EU Regulations regarding the sustainable development of agriculture by reducing the consumption of chemical fertilizers in order to protect environment, preserve biodiversity and ensure food safety are justified, but they have to be applied in a different manner from a country to another depending on its actual use of mineral fertilizers per ha UAA, yield level of agricultural crops and the need to increase productivity, farmers' income and profit.

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PESTICIDES - A PROBLEM IN ROMANIA'S AGRICULTURE?

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Abstract

The paper analyzed the use of pesticides in Romania in the period 2007-2020, based on the official statistical data by type of pesticide, at the national and territorial level, and using fixed and structural indices, concentration indices and time and spatial comparisons. In the year 2020, pesticides were applied on larger surfaces than in 2007 and they accounted for 3.88 million ha for herbicides, 2.39 million ha for fungicides, and 2.34 million ha for insecticides. But, the total consumption decreased by 26% for insecticides and by 23% for herbicides, but it increased by 8.2% in case of fungicides. The national mean consumption of pesticides per ha declined and in 2020 accounted for 0.27 kg a.s. insecticide, 0.75 kg herbicide and 0.76 kg fungicide. Romania comes on the last position in the EU for the smallest average consumption 0.8 kg a.s. pesticide per ha and also for the risk indicator 1 equal to 48. The largest areas where pesticides are applied in the territory are in South Muntenia, West, South East and South West Oltenia micro-regions. Total consumption differs from a region to another as follows: insecticides are much more consumed in South West Oltenia, South Muntenia, North East, South East and West, fungicides are especially applied in South East, North East, Center and West, and herbicides are predominantly utilized in North East, South East, North West, South West Oltenia, and West. The average consumption per ha, over the national mean, is higher in the following regions: insecticides in North West, South West Oltenia, Center and North West, fungicides in the Center, Bucharest-Ilfov, South East and North East and herbicides in North East, North West and Center regions. The values of the concentration indices Herfindahl-Hirschman, Gini-Struck and Concentration coefficient proved that in 2020, Romania was characterized by a relative moderate concentration of the use of pesticides. As a conclusion, pesticides have to be used taking into consideration the local conditions at the regional level and at farm level. Farmers have to evaluate the problems and make the best decision regarding what type of pesticide to use, on what surface, which is the suitable dose per ha, how many treatments are required etc. The EU regulations regarding pesticides imposes a strict control and use of the approved pesticides for compiling with the European the Green Deal.

Key words: *pesticides, consumption, dynamics, territorial dispersion, Romania*

INTRODUCTION

The existence of the risk of the diseases and pests in agriculture can diminish yields, harvests, and farmers' income and profit. In general, the use of pesticides provides a higher yield and also reduces the cost of labor, and farmers have to give a response to the question: Is it wise to save a harvest or to lose it? And they are obliged to make the decision "to save", as this is their business!
Also, the use of pesticides prolongs food shelf life [1, 28].
This justifies the development of the chemical industry which produce pesticides.
The chemicals referring to pesticides are of a large variety, depending of their components and, functions: for destroying weeds, for controlling insects and killing the useless ones for agriculture, for combating diseases caused by fungi and bacteria and for preventing and treating the pests attack. About 90% of pesticides are herbicides [3, 29].
Climate change could influence the increase of the incidence of pests and pathogenic agents attack on agricultural crops, but it is

still considered to have a minor role, the main drivers in the use of pesticides being agronomic, economic, environment reasons and social reasons [9, 12].
The widespread use of pesticides and other chemicals like fertilizers has lead to the release and remanence of the toxic residues in the environment polluting air, water, soil, non-target plants, animals, affecting biodiversity, and in food, putting in danger human health and life [8, 10, 27, 30, 32].
That is why the use of pesticides has become controversial, and the reduction or elimination is imposed by policy makers for developing a sustainable agriculture, friendly with environment and for ensuring food safety [13, 15].
Solutions are diversified and could include a careful ecosystem management, the use of crop rotation and of a healthy soil practice which favors the stimulation of the beneficial microorganisms, the application of the integrated systems for combating weeding, and also measures to stimulate useful insects and eliminate the destroying ones, in a word to implement the so called Integrated Weeding and Pest Management. More than this, the farmers could easily use other techniques regarding tilling, planting cover crops and applying a different time, early or late, for starting crops to avoid weeding. And, the existence of non-chemical pesticides could be also another solution [14].
Therefore, we must not deny the use of pesticides which is essential for ensuring the plant protection and food production.
Even in the organic agriculture which looks to become a strong competitor for conventional agriculture in the way to a healthier environment and food, the use of pesticides is allowed, but taking into consideration only the approved types of pesticides and the limited amount to use.
Therefore, pesticides production and use is under a strict regulation and control nowadays as a response to the need for producing more bio-based products using modern environmentally friendly technologies and healthy food [26].
The EU has developed a long run strategy which provides the reduction of pesticides in agriculture by 50% by 2030 by the extend of organic agriculture from 10% at present to 25% [2, 7].
The application of pesticides differs from a country to another and from a region to another depending on soil and climate conditions, farm size, crop structure, agricultural system utilized etc.
Taking into account the heterogeneity of agronomic conditions, pesticide policy has to respond to the specificity of each country adapted to the local conditions.
However, the EU policy regarding the use of pesticides is justified for creating a harmonized framework of the national policies, so that the pesticides allowed to be used to contain only the approved substances and no new pesticide to enter the market without being authorized by the EU country when it will be used [4, 5, 6, 28].
In this context, the goal of the paper was to analyze the situation of pesticides in Romania during the period 2007-2020, regarding the areas where these chemical substances were used, the quantities consumed and the average consumption per surface unit, the degree of concentration of the pesticide use at regional level as finally to assess in what measure the utilization of pesticides in Romania is a problem and in which way the country to adapt and align to the EU regulations in force.

MATERIALS AND METHODS

A brief presentation of Romania's agriculture

Romania is an EU country where agriculture is an important sector of the economy and plays an important part of the European agriculture. Romania has a fertile soil and in general a favourable climate, a large range of arable crops (cereals, oilseeds crops, technical crops etc) [16, 21] which could be cultivated and also orchards, vineyards and grasslands, and animal sector is represented by cattle, swine, poultry, sheep and goats, beekeeping subsectors which give their contribution to the agricultural output value [11] and GDP [17, 23, 25].
The main characteristics of Romania's agriculture are: the large number of holdings

accounting for about 3.2 millions, for which Romania comes on the 1st position among the EU member states, the small-sized farms of around 3.67 ha, the high share of 78% of the vegetal sector in the agricultural output, and the main products achieved are cereals (wheat, corn, barley, etc) [21, 24], sunflower seeds [22], potatoes, grapes, wine, milk, pork, poultry, eggs, honey [18, 19, 20].

The main agricultural system applied is the traditional one, specific to subsistence and semi-subsistence agriculture, but in the large agricultural holdings, conventional agriculture is applied on a large-scale. Organic farming is still shade, but its importance is increasing.

Family farming is dominant running in very small sized farms, 98% of farms having less than 10 ha and the productivity being below the production potential. Only 1% of the farms are represented by agricultural commercial companies with high performances and they work about 46% of arable land.

The need of agricultural inputs like seeds, seeding materials, fertilizers, pesticides, fuels, equipments etc, is facing more and more with price volatility and the small or lack of financial resources.

The uncertainty of the future harvests due to the climate change, the lack of labour, aging, migration are other problems which transform agricultural business into a high risk goal.

Data collection

The study is based on the official data provided by National Institute of Statistics, Tempo Online data base for the period 2007-2020.

Methodological approach

In this study, there were used the following indicators: the surface where pesticides were utilized, the total consumption of pesticides, and the average consumption per ha.

The analysis is made, on one side, at the national level, and on the other side, in the territory, for studying how pesticides were used in the eight micro-regions.

Fixed basis indices, structural indices, and also the degree of concentration of the use of pesticides in terms of Herfindahl-Hirschman Index, Gini-Struck Index and the Coefficient of Concentration, time and spatial comparisons have been the main procedures involved in this research work

The results were comprehensively displayed in tables and graphics which allow the understanding of the dynamics and correlative relationships between the studied indicators.

The main conclusions were presented at the end of this paper.

RESULTS AND DISCUSSIONS

The surface on which pesticides were utilized

After Romania's entry into the EU in January 2007, agriculture tried to enforce and strengthen its position among the other states. To increase productivity, fertilizers and pesticides were among the main farm inputs to which farmers paid attention.

In consequence, the utilization of pesticides was justified by the need to ensure plant protection and reach the expectations regarding production.

In the period 2007-2020, the surfaces where pesticides were applied increased by +42.9% in case of insecticides, by +52.5% in case of fungicides and by +31.1% in case of herbicides. Therefore, in 2020, the insecticides were used on 2,343 thousand ha, fungicides on 2,395 thousand ha and herbicides on 3,887 thousand ha (Fig. 1).

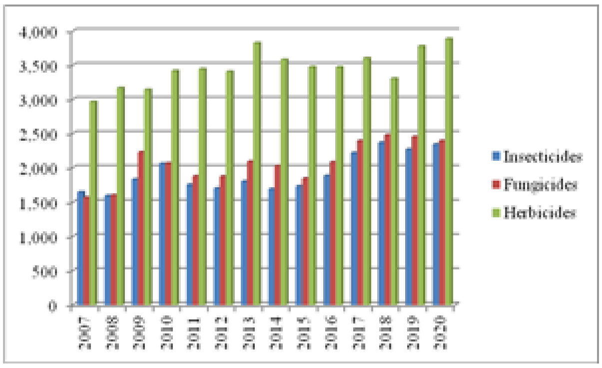

Fig. 1. Dynamics of the agricultural area where the pesticides were used in Romania, 2007-2020 (Thousand ha)
Source: Own calculation and design based on NIS data, 2021 [11].

Plant protection measures were imposed due to the extent of the cultivated area, crop structure, the new technologies in crop farming and the need to adapt to climate

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change (droughts, huge rainfalls, pathogenic agents, weeding etc).

The total amount of pesticides utilized reflected the problems which appeared for plant protection in the country in the last 13 years. In the analyzed period 2007-2020, the total amount of insecticides active substance (a.s.) consumed declined by -25.8%, the amount of herbicides also decreased by -23%, but the quantity of fungicides increased by +8.25%. This means that the cultivated areas in the country had less problems with the attack of insects and weeding and more problems with the appearance of diseases caused by fungi.

In 2020, there were consumed the following amounts of pesticides: 641 tons a.s. insecticides, 1,823 tons a.s. fungicides and 2,901 tons a.s. herbicides. Therefore, from this point of view, it is clear that weeding is the biggest problem in Romanian agriculture, on the second position coming the diseases produced by various pathogenic agents and on the third position is the attack of insects (Fig. 2).

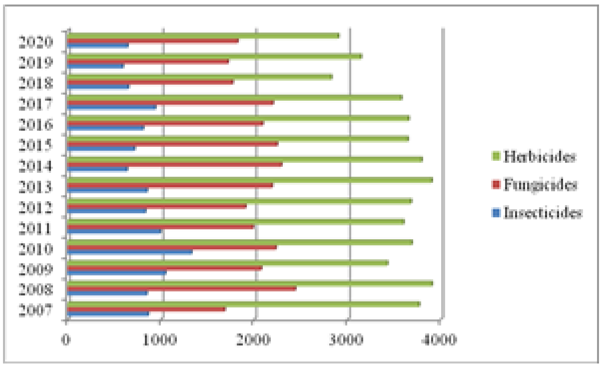

Fig. 2. Dynamics of the total amount of pesticides used in Romania, 2007-2020 (Tons 100% active substance)
Source: Own calculation and design based on NIS data, 2021 [11].

The average quantity of pesticide utilized per ha

In the year 2020, in Romania it was consumed 0.27 kg a.s./ha insecticide, 0.76 kg a.s./ha fungicide and 0.75 kg a.s./ha herbicide, much less than in the year 2007. The reduction in consumption per ha of the level in the year 2007 by type of pesticide was the following one: -48.1% in case of insecticides, -29% in case of fungicides and -41% in case of herbicides. Therefore, we may affirm that the consumption was deeply in a descending trend in Romania (Fig. 3).

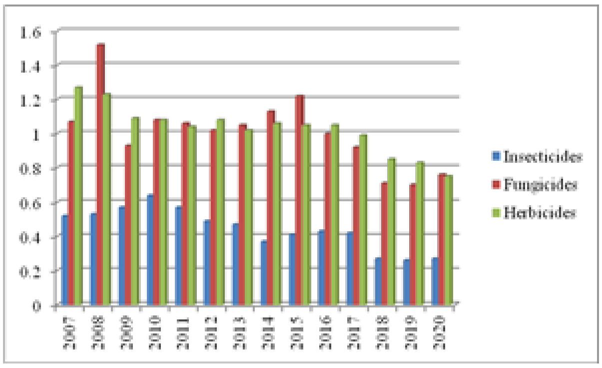

Fig. 3. Dynamics of the quantity of pesticides applied per surface unit in Romania, 2007-2020 (kg a.s./ha)
Source: Own calculation and design based on NIS data, 2021 [11].

In 2018, Romania consumed 6.9 thousand tons pesticides for which it came on the 10th position in the EU after France, Spain, Italy, Germany, Poland, Hungary, Greece, Portugal, Netherlands, countries utilize higher amounts of pesticides [31].

Regarding the consumption of pesticides per surface unit for 0.8 kg/ha in average, Romania is situated on the last position in the EU. We could not compare its consumption with the top member states consuming a higher average amount than 3.6 kg/ha, which are, in the ascending order: the following ones; Spain, France, Germany, Portugal, Italy, Ireland, Belgium, Netherlands and Malta, the last one having the highest position for 12 kg/ha [31].

Also, Romania has the lowest risk indicator 1 for pesticides by active substance in the EU, accounting for 48. For this reason, Romania came on the last position compared to the EU average risk indicator which is 83 and which is exceeded by 10 member states with over 84, in the increasing order being: Hungary 84, Lithuania 86, Italy 91, France 100, Slovenia 109, Austria 129, Estonia 131, Cyprus 134, Latvia 140 and Finland 144 [4].

The use of pesticides in the territory of Romania

The dispersion of surfaces where pesticides were used in the territory reflects a different situation from a micro region to another and also from a type of pesticide to another.

(a)Insecticides. In 2007, insecticides were applied on larger surfaces in South East (30.2%), South Muntenia (20.7%), South West Oltenia (17.8%), summing 68.9% of the total agricultural area of 1,649,500 ha where pesticides were utilized.

In 2020, in comparison with the year 2007, a higher surface was used for applying pesticides from the first category, that is insecticides. The highest increase of the surface was noticed in North East (+96.5%), South Muntenia (+85.3%), Bucharest-Ilfov (+189.8%), South West Oltenia (+20.3%) and West (+237.3%).

As a result, in 2020, the highest share in the area where insecticides were used belonged to South Muntenia (27.07%), West (19.3%), South East (17.1%), South West Oltenia (15.1%), totaling 78.7% of the total treated area accounting for 2,343,099 ha.

(b)Fungicides. In 2007, the treatments with fungicides were applied especially in South East, South Muntenia, South West Oltenia, North East, North West, whose share in the total agriculture surface of 1,574,310 ha was: 31.1%, 18%, 12.7%, 11.03% and, respectively, 10.03%.

In 2020, the area where fungicides were utilized increased in North West (+42.1%), Center (+30.3%), North East (+127.9%), South Muntenia (+78.1%), Bucharest-Ilfov (+206%), South West Oltenia (+67.6%), West (+180.2%). Only in South East, it declined by 28.9%.

Therefore, in 2020, the share of various regions in the surface of 2,395,430 ha, where fungicides were distributed, was the following one, in the descending order: South Muntenia (21.08%), West (19.28%), South East (14.56%), South West Oltenia (14.03%), North East (13.6%), summing 82.6%, the remaining belonging to North West, Center and Bucharest-Ilfov.

(c)Herbicides. In 2007, herbicides were applied on 2,963,526 ha, of which the highest weight of the agricultural land belonged to South Muntenia (22.3%), South East (20.7%), West (16.5%), totaling 60%. In other micro-regions like North West, Center and North East, the shares were smaller: 11.37%, 9.52% and 9.01%, while Bucharest-Ilfov had just 0.88%.

In 2020, the agricultural surface where herbicides were utilized increased in North West (+120.6%), South East (+55.2%), South Muntenia (+44.1%), Bucharest-Ilfov (+51.8%), South West Oltenia (+87.5%) and West (+12.9%) (Table 1).

Table 1. Surface where pesticides were applied by micro-region of Romania in 2020 compared to 2007

	Insecticides		Fungicides		Herbicides	
	2007	2020	2007	2020	2007	2020
Total Romania (Thousand ha)	1,649.5	2,343.0	1,574.3	2,395.4	2,963.5	3,887.3
Share (%) of the micro-region						
North East	9.29	4.47	10.03	9.61	11.37	8.32
Center	4.79	4.25	7.84	6.72	9.52	6.33
North East	8.32	11.52	11.03	13.68	9.01	15.15
South East	30.28	17.11	31.13	14.56	20.72	16.63
South Muntenia	20.74	27.07	18.00	21.08	22.33	24.54
Bucharest-Ilfov	0.52	1.06	0.51	1.04	0.88	1.02
South West Oltenia	17.88	15.15	12.74	14.03	9.62	13.75
West	8.18	19.37	8.72	19.28	16.55	14.26

Source: Own calculation based on the data from NIS, 2021 [11].

As a result, the share of the micro-regions in the total surface of 3,887,385 ha where herbicides were used, became as follows: South Muntenia (24.5%), South East (16.6%), North East (15.1%), West (14.2%), South West (13.7%) totaling 84.3%, the difference belonging to North West, Center and Bucharest-Ilfov (Table 1).

The concentration indices regarding the surface where pesticides were utilized obtained the following values:

- Herfindahl-Hirschman Index, HHI, varied between 0.15 and 0.25 showing a moderate concentration for all the types of pesticides and in all the micro-regions.

-Gini-Struck Index, GSI, had values below 0.3, also reflecting a relative concentration of the agricultural land treated with pesticides, no matter the type of pesticide or the micro-region.

-Concentration Coefficient had higher values than HHI and GSI, taking into consideration the relationship existing among these indicators from a mathematical point of view. Therefore, its values reflected the same idea.

Comparing the values of the concentration indices resulting in 2020 with the values recorded in 2007, we noticed that HHI registered lower values in case of the surface treated with insecticides and fungicides, and that in case of the area treated with herbicides the values of these indicators was higher. Similar tendencies were noticed in case of GSI and CC (Table 2).

Table 2. Concentration degree of the surfaces treated with pesticides in Romania in 2020 compared to 2007

	Insecticides		Fungicides		Herbicides	
	2007	2020	2007	2020	2007	2020
Herfindahl-Hirschman Index	0.1908	0.1798	0.1813	0.1547	0.1592	0.1698
Gini-Struck Index	0.2742	0.2502	0.2536	0.1842	0.1977	0.2025
Concentration Coefficient	0.3133	0.2870	0.2898	021.05	0.2259	0.2314

Source: Own calculation.

Dispersion of total consumption of pesticides by micro-region

(a)Insecticides. In 2007, in Romania it was consumed an amount of 863,108 kg a.s. insecticides in agriculture. The biggest amounts were applied in South West Oltenia (23.3%), South East (19.09%), South Muntenia (17.1%), North East (14.7%) and North West (10.8%) summing 85.1%. Smaller quantities were utilized in the Center and Bucharest-Ilfov.

In 2020, the insecticides were used in a smaller amount, accounting for only 640,945 kg, meaning by 25.8% less than in 2007.

However, in the territory, the quantity of used insecticides increased only in the West region (+18.1%), while in the other regions it declined as follows: North East (-37%), Center (-11.3%), North East (-35%), South East (-59%), South Muntenia (-37%), Bucharest-Ilfov (-58.9%) and South West Oltenia (-3.3%).

In the year 2020, the regions with a higher consumption of pesticides were: South West Oltenia (30.4%), South Muntenia (14.6%), North East (12.9%), South East 912.7%), West (12.09%), summing 82.69%. In North West and Bucharest Ilfov, the shares of the used insecticides were smaller than in the other regions.

(b)Fungicides. Of the amount of 1,683,848 kg a.s. fungicides used in 2007, the largest quantity was consumed in North West (23.3%), South East (22.1%), Center (13%), South Muntenia (10.9%), North East (10.9%), South West Oltenia (9.9%) and West (9.5%). In Bucharest-Ilfov, it was used only 0.24%, an insignificant amount.

In the year 2020, the consumption of fungicides increased especially in North East (+111.5%), West (+43%), the Center part of the country (+36.1%), South East (+22.4%), and Bucharest-Ilfov (+792%).

In consequence, the highest share in the total consumption of 1,822,965 kg a.s. belonged to South East (25.03%), North East (21.3%), followed by Center (16.3%) and West (12.6%).

(c)Herbicides. In 2007, there were consumed 3,767,126 kg a.s. herbicides. The highest

shares in this quantity belonged to North West (19.3%), West (19.4%), South Muntenia 918%), South East (17%), summing 73.7%. Smaller amounts were utilized in the other micro-regions.

In 2020, the amount of herbicides declined accounting for 2,90,538 kg a.s. meaning by 23.1% less than in 2007. In the territory, the utilized amount of herbicides increased in North East (+89.9%), Bucharest-Ilfov (+184 times), South West Oltenia (+36.8%).

In the other regions, the amount of applied herbicides decreased as follows: in North West (-46%), Center (-17%), South East (-30%), South Muntenia (-50%) and West (-68%).

As a result, in 2020, the highest weight in total consumption belonged to: North East (25%), South East (15.5%), North West (13.6%), South West Oltenia (12.6%), South Muntenia (11.7%), and West (10.6%) (Table 3).

Table 3. Total consumption of pesticides by micro-region of Romania in 2020 compared to 2007

	Insecticides		Fungicides		Herbicides	
	2007	2020	2007	2020	2007	2020
Total Romania (kg)	863,108	640,945	1,683,848	1,822,965	3,767,126	2,900,538
Share (%) of the micro-region						
North East	10.81	9.26	23.31	6.89	19.33	13.66
Center	5.87	7.10	13.00	16.35	8.66	9.39
North East	14.75	12.96	10.90	21.30	10.37	25.59
South East	19.09	12.78	22.12	25.03	17.00	15.52
South Muntenia	17.12	14.62	10.96	8.98	18.08	11.74
Bucharest-Ilfov	1.40	0.78	0.24	2.05	0.03	0.82
South West Oltenia	23.34	30.41	9.92	6.78	7.12	12.65
West	7.62	12.09	9.55	12.62	19.41	10.63

Source: Own calculation based on the data from NIS, 2021 [11].

The concentration indices regarding total consumption of herbicides had the following values:

- The values of Herfindahl-Hirschman Index varied between 0.15 and 0.25 reflecting a relative moderate concentration for all the types of pesticides and also by micro-region.

-Gini-Struck Index and Concentration Coefficient showed higher values than Herfindahl-Hirschman Index which also reflected the same relative moderate concentration.

Table 4. Concentration degree of the consumption of pesticides in Romania in 2020 compared to 2007

	Insecticides		Fungicides		Herbicides	
	2007	2020	2007	2020	2007	2020
Herfindahl-Hirschman Index	0.1627	0.1748	0.1628	0.1646	0.1595	0.1577
Gini-Struck Index	0.2075	0.2385	0.2078	0.2127	0.1985	0.1933
Concentration Coefficient	0.2371	0.2725	0.2374	0.2430	0.2268	0.2209

Source: Own calculation.

-In 2020 compared to the year 2007, the values of Herfindahl-Hirschman Index, Gini-Struck Index and Concentration Coefficient registered an ascending trend for the consumption of insecticides and fungicides, while for herbicides it was noticed a decreasing tendency (Table 4).

Average consumption of pesticides in the territory by micro-region

Analyzing the situation of average consumption per surface unit, we noticed that in the year 2007, the mean at the country level was exceeded only in Bucharest-Ilfov (more than double), in North East, South West Oltenia, Center, North West, but in the other region it was below the national mean.

In the year 2020, the country average accounted for 0.27 kg a.s./ha insecticide, which was exceeded only in North West and South West Oltenia, having the top consumption of 0.57 kg/ha and 0.55 kg/ha, and the lowest consumption was 0.15 kg/ha in South Muntenia.

In 2007, the average consumption of fungicides was higher in North West, Center, North East, while in the other regions was smaller. In 2020, the country mean declined to 0.76 kg a.s./ha, and it was exceeded in the Center, Bucharest-Ilfov, South East, and North East, while in the other regions it was much lower.

Regarding the average consumption of herbicides per ha, in 2007 compared to the country mean of 1.27 kg a.s./ha, in the West part and North West it was consumed more than double and in North East a little more, while in the other regions it had a very low level. In 2020, the country mean of 0.75% herbicide a.s/ha was exceeded only in North East, North West and Center, while in the other micro-regions the levels were smaller (Table 5).

Table 5. Average consumption of pesticides by micro-region of Romania in 2020 compared to 2007 (kg a.s./ha)

	Insecticides		Fungicides		Herbicides	
	2007	2020	2007	2020	2007	2020
Total Romania (kg)	0.52	0.27	1.06	0.76	1.27	0.75
Average consumption of pesticides by micro-region						
North East	0.61	0.57	2.48	0.55	2.16	1.22
Center	0.64	0.46	1.77	1.85	1.15	1.11
North East	0.93	0.31	1.27	1.18	1.46	1.26
South East	0.33	0.20	0.76	1.31	1.04	0.70
South Muntenia	0.43	0.15	0.65	0.32	1.03	0.36
Bucharest-Ilfov	1.41	0.20	0.51	1.50	0.005	0.60
South West Oltenia	0.68	0.55	0.83	0.37	0.94	0.69
West	0.49	0.17	1.00	0.49	2.56	0.55

Source: Own calculation based on the data from NIS, 2021 [11].

CONCLUSIONS

This study pointed out that in Romania during the period 2007-2020, the surface where pesticides were applied increased and accounted for 3.88 million ha for treatments against weeding, 2.39 million ha for treatments against fungi and 2.34 million ha for treatments against insects.

But, the total amount of pesticides utilized declined by 26% for insecticides and by 23% for herbicides, but it increased by 8.2% in case of fungicides.

As a consequence, the average consumption of pesticides per surface unit declined and in 2020 accounted for 0.27 kg a.s. insecticide, 0.75 kg herbicide and 0.76 kg fungicide at the national level.

For an average consumption of 0.8 kg a.s./ha, Romania comes on the last position in the EU. Also, for the lowest level of the agri-environment indicator in terms of "the risk indicator 1" equal to 48, Romania is also situated on the last position among the EU member states.

Based on the territorial analysis at the regional level, we identified that the largest areas where plant protection measures are required, in the decreasing order, are: South Muntenia, West, South East and South West Oltenia. In the other micro regions, pesticides are utilized on smaller surfaces. Also, the total consumption of pesticides depends on the type of pesticide suitable to solve specific problems in plant protection and on the micro-region, because of the geographical disparities among regions regarding soil and climate conditions, crop mapping, farm types and size, technologies applied etc.

Insecticides are much more consumed in South West Oltenia, South Muntenia, North East, South East and West where the temperatures have higher average levels and droughts are frequently a big problem and favor a higher incidence of insect attack.

The highest amount of fungicides is used in South East, North East, Center and West where the incidence of diseases caused by fungi is higher than in other regions.

Higher quantities of herbicides are used in North East, South East, North West, South West Oltenia, and West where the risk of damages caused by weeding is very high.

The highest average consumption of pesticides per ha, over the national mean, is differentiated by type of pesticide and also by region. From this point of view, the highest level of insecticides used over the national mean was found in North West, South West Oltenia, Center and North West. The highest level of fungicide per ha and over the national mean was applied in the Central part, Bucharest-Ilfov, South East and North East. And the highest amount of herbicide per surface unit, and over the national mean was consumed in North East, North West and Center regions.

The values of the concentration indices Herfindahl-Hirschman, Gini-Struck and Concentration coefficient proved that in 2020, Romania was characterized by a relative moderate concentration of the use of pesticides.

Therefore, the application of pesticides reflects that the strategic measures for plant protection have to take into consideration the local conditions at the regional level and also within the regions at the level of each farm where the farmer is the only person who knows the problems the best. Farmers have to evaluate the problems and make the right decision regarding the complex of plant protection measures regarding what type of pesticide to use, on what surface, which is the suitable dose per ha, how many treatments are required etc.

Farmers have to be aware of that the development of a sustainable agriculture involves more production and products of higher quality, and also environment protection and food safety. For this reason, the EU regulations regarding pesticides imposes a strict control and use of the approved pesticides for compiling with the European the Green Deal which aims, among other goals, a modern, resource-efficient and competitive agriculture called "to ensure food security, to diminish the environment and climate footprint of the food system, to confer a competitive sustainability from farm to fork".

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IDENTIFICATION OF THE RELEVANT STAKEHOLDER GROUPS - THE FIRST STEP TO THE STRATEGIC STAKEHOLDER MANAGEMENT IN AGRICULTURAL HIGHER EDUCATION - A STUDY CASE IN THE REPUBLIC OF MOLDOVA

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Abstract

The growing competition in the market of educational services requires increased efforts to ensure an adequate quality of the educational products offered by vocational education institutions. However, reaching the adequate quality standards is impossible without the active involvement of stakeholders. Only through the synergy of the efforts of all groups of stakeholders, the progress in the quality of educational services provided can be achieved - a particularly important task especially for agricultural vocational education, which has a strategic significance for the Republic of Moldova. Knowing and correctly perceiving their role in this regard is required as an indispensable factor of quality and performance. The basic objectives of the research were: a) mapping the stakeholders of the State Agrarian University of Moldova; b) evaluation of the stakeholders' perception by the management team and the university staff. In order to achieve these objectives, the following research tools were used: the synthesis of a series of scientific publications with reference to the emergence and evolution of stakeholder theory in higher education; mapping process; structured thematic interview; tabular and graphical presentation of the primary data; structural analysis; descriptive method. As a result of the research, the mapping of the stakeholders of the State Agrarian University of Moldova was performed. Also, the areas that require intervention in the quality of stakeholder perception by university managers and teaching staff were identified: more active promotion of the value of stakeholders; increasing the level of involvement of the teaching staff in collaborative activities with external stakeholders.

Key words*: *competition, higher education, quality, performance, State Agrarian University of Moldova, stakeholder

INTRODUCTION

Growing competition in all areas of activity requires more efforts to identify the most effective tools for ensuring performance. In this context, the attention of researchers and practitioners is increasingly focused on stakeholders/ beneficiaries of the goods offered, their role in ensuring the success of organizations being obvious. Implicitly, the term "stakeholder" (borrowed from English) penetrates more and more insistently into the scientific and managerial language.

In order to improve the knowledge on the ways of optimal use of the relations with the stakeholders for the success of the activities carried out, a large number of scientific research have been made, thus crystallizing the theory of the stakeholders. At the same time, there are a number of issues related to both the conceptual approach of stakeholders and the quality of their use by organizations, including educational ones.

Being stated as a managerial conception of organizational strategy and ethics, stakeholder theory is based on the idea that the organization`s success depends on the quality of managing the relationships with key groups, such as: consumers, employees, suppliers, communities, financiers, etc. which may affect the achievement of objectives [5; 13]. Although considered relatively new, stakeholder theory is driven by a growing interest from both researchers and practitioners in various fields [2; 3; 4; 5; 6; 13]. In 1995, Donaldson and Preston found out that since the publication of Freeman's book "Strategic Management: A Stakeholder Approach" in 1984, there have been edited about a dozen books and more than 100 scientific papers with a main focus on the concept of stakeholder (mentioning the contribution made, through books and articles, by Alkhafaji, Anderson, Brummer, Brenner, Cochran, Clarkson, Goodpaster, Hill, Jones, Wood, etc.) [3]. Certainly, today the number of publications on this subject is much higher. At the same time, there is a lack of common views on a series of related issues, this fact being noticed by researchers in the examined field [2; 3; 4; 13]. A first divergence can already be identified at the stage of defining the term "stakeholder". Researches show that, in its historical evolution, the concept of stakeholder has amplified, starting from the meaning of "a person entrusted with the stakes of bettors", later being complemented with the meaning "one who has a share or an interest, as in an enterprise" [2]. The conceptual approach of stakeholders differs from case to case, especially based on the concrete examined actors. Thus, while some authors refer to stakeholders as only to the individuals or groups who have the power to directly affect the future of an organization, others call for a wider range of people, groups, or organizations to be considered, which have no power of influence, such an approach being considered more compatible with the principles of democracy and social equity [2]. We justify the broader approach of stakeholders, due to the fact that the absence of direct influence does not mean the complete absence of influence - the future and sustainability of the organization may be affected indirectly as a result of their decisions and actions. In this context we can highlight, as having an optimal relevance, the definition given by Freeman (quoted by Wang et al.) that defines stakeholders as "any individual or group of individuals either impacted upon the company or able to impact on the achievement of its objectives" [13].

The right, comprehensive approach to stakeholders is especially important for any entity. Thus, some of them are important for the organizational performance, while others are important because of the impact caused by the organization on them. The role of the organization is to be aware of both categories and to manage them successfully, „the former for reasons of effectiveness, the latter for reasons of legitimacy and ethicality" [11]. By disregarding certain categories of actors, the opportunities to be successful and competitive are diminished.

The significance of the correct approach of stakeholders by higher education institutions is as great as in the case of organizations in any other field, being noticed even its increase in the contemporary university environment [8]. Moreover, the process of marketization of the vocational education has been imposed by major changes in the market of the educational services, requiring considerable administrative efforts to balance the internal needs for differentiating programs with the external ones in order to integrate them into a wide community [12]. Today, universities are increasingly examined in terms of economic and social contributions. Thus, before defining relational priorities and strategies, universities need to identify stakeholders and their needs, even if this is not an easy task [8]. The first step would be to start from the specifics of the educational and scientific university offer and, respectively, to determine who would have interest in the respective services, directly or indirectly, immediately or in the medium and long term. Such an approach to the problem is also confirmed by the definition of the stakeholder set out in the Romanian explanatory dictionary: "body or category of people with major interests in the conducting and results of the company's activities" [11].

A comprehensive synthesis of the approaches regarding the stakeholders of higher education institutions can be found in the work "Identifying stakeholders in a Portuguese university: a case study" elaborated by the group of authors: Mainardes, Alves and Raposo [8] in which 25 researches in the respective field have been analyzed and generalized. There can be mentioned the great interest to the subject and the perseverance of the respective group of authors, taking into consideration that, in a previous study [1] they identified and analyzed 16 papers focused on the stakeholders of higher education institutions. With regard to the nomination of higher education institutions` stakeholders, we find out that the views are very varied. Thus, while some researchers refer to stakeholders only as 2-3 actors, internal or/and external ones, others present much larger lists [8; 9; 13]. Based on the reasoning set out above regarding the need to identify all people and organizations interested in the educational and scientific services provided by universities, we consider relevant the broader approaches of stakeholders. At the same time, among the attempts to systematize the stakeholders, we can mention Kettunen [7] who considers that the stakeholders can be classified in two categories: internal and external. The author refers to internal stakeholders, students and staff, while consumers and partners are included in the category of external ones. According to Mainardes et al. [8], we can also distinguish between individual and collective, as well as academic and non-academic stakeholders. It should be noted that the identification of stakeholders in higher education institutions represents the initial component of the strategic stakeholder management, the latter involving the following stages: I. Identification of the relevant stakeholder groups for organizational management; II. Establishing the significance and level of participation of each stakeholder group; III. Assessing the extent to which their needs and expectations are met at the current stage; IV. Changing corporate policies and ranking priorities in accordance with stakeholder interests [8].

The question: "Why is it important to systematize the stakeholders of higher education institutions?" can be answered by the following arguments: a) the systematization process can ensure a more accurate and comprehensive identification of actors interested in the educational and scientific offer of higher education institutions; b) the systematization itself facilitates the process of modeling the system of relations between the educational institution and stakeholders, but also between different actors, so as to optimize the quality of those relations. In the context of those highlighted above, we will refer to Kettunen who states that for higher education institutions it is important not only to identify stakeholders, but also to classify them in order to connect them to strategic management [7]. A similar vision can be found at Mainardes et.al [8], who, as previously mentioned, highlights the process of identifying and systematizing stakeholders as an initial stage of strategic stakeholder management.

MATERIALS AND METHODS

The research methodology was focused on the objectives pursued, namely: a) mapping the stakeholders of the State Agrarian University of Moldova; b) evaluation of the stakeholders' perception by the management team and the university staff. In order to achieve the first objective, the synthesis of a series of scientific publications referring to the emergence and evolution of stakeholder theory, their role and composition was carried out. By using the mapping process, the stakeholders of the State Agrarian University of Moldova were systematized. For the second objective, an opinion survey was conducted on a sample of 103 respondents, including: 7 representatives of senior management, 8 representatives of faculty management (deans and vice-deans), 7 heads of department and 81 representatives of the teaching staff. For this purpose, the method of the structured thematic interview was used, being conducted between February and July 2021. For the primary data processing, the tabular and graphical presentation was used. The analysis of the obtained data was performed using the structural analysis and the descriptive method. The research limitation is related to the low representativeness of the teaching staff in the composition of the researched sample.

RESULTS AND DISCUSSIONS

At the present stage, higher agricultural education in the Republic of Moldova is facing particularly strong market pressures, generated mainly by the continuous and rapid reduction in the number of candidates for studies and, as a result, by increasing competition in the market of educational services. Due to the low image of agriculture, it is obvious that in order to be competitive, the State Agrarian University of Moldova (this being the only agricultural higher educational institution in the country) must make greater efforts compared to the education institutions focused on other industries. Moreover, the respective university is often examined as a promoter, but also blamed (unjustifiably) for the problems related to the efficiency and, implicitly, to the image of the agricultural activities. In the context of the above mentioned, we deduce that the correct identification and systematization of all stakeholders, the design of a system of effective, rational relations with them is required as a factor of great importance for the success of the institution. At the same time, it is important to take into consideration some significant aspects, deduced from the related research, and also the lessons learned: a) stakeholders do not exercise only separate influences, most often being in relationships with each other. As a result, the educational institution must be able not only to manage correctly and as effectively as possible the relationship with each of them, but also to make the best use of the results of the synergy of the efforts of different actors. Moreover, the institution must facilitate this system of relations; b) if the impact exerted by some stakeholders is direct and immediate, others exert indirect influences. On this basis, we consider it relevant to classify stakeholders not only by origin, in internal and internal ones, but also depending on how they exercise influence, in stakeholders of the university microenvironment and of its macro environment. Thus, the actors who can directly and immediately affect the activity of the institution will be referred to the microenvironment, while those who cannot exert an immediate influence - to the macro environment. Respectively, for each category, appropriate motivation and communication tools should be identified, in order to increase the quality of the activities carried out by the educational institution. Based on the synthesis of opinions regarding stakeholders, presented by various researchers and practitioners, as well as taking into consideration the endogenous and exogenous environment of the examined institution, a mapping of stakeholders was performed, as shown in Figure 1.

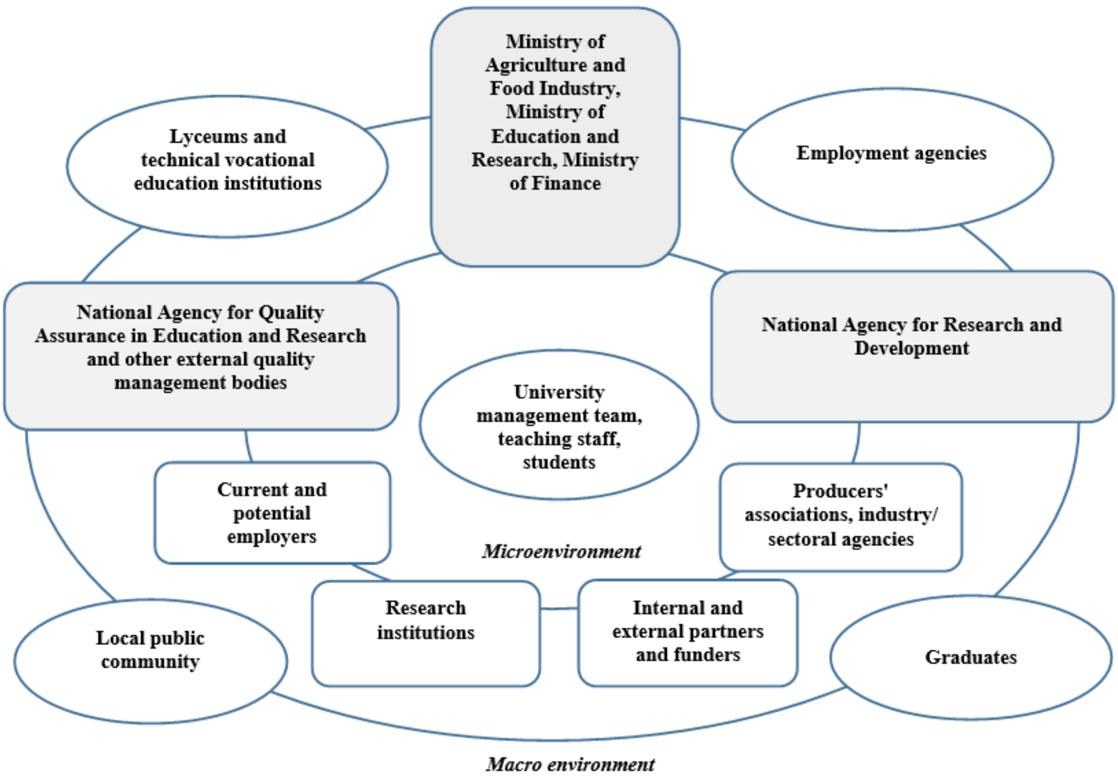

Fig. 1. Mapping stakeholders of the State Agrarian University of Moldova
Source: Developed by the authors.

According to the data in Figure 1, there are at least four actors that form a stable microenvironment of the educational institution: employers; various producer associations as well as industry/sectoral agencies; research institutions; internal and external partners and funders (partner institutions in various joint educational and research projects, external funders etc.). To the stakeholders of the institution's macro environment can be referred: employment agencies; graduates; lyceums and technical vocational education institutions; the local public community. At the same time, based on the large number of responsibilities of certain actors, some of which being subject of the direct relations with the institution, while others having an indirect impact on it, we consider that three categories of stakeholders can be referred both to the microenvironment and macro environment: three ministries; the National Agency for Quality Assurance in Education and Research and other external quality management bodies; the National Agency for Research and Development.

The usefulness of stakeholder systematization can be argued by the following: a) by highlighting the stakeholders in more detail, premises are created for establishing the collaboration relations with a wider series of actors, thus optimizing their contribution in increasing the quality of the services provided by the institution; b) by systematizing the external stakeholders by groups, respectively of the microenvironment and macro environment, the process of identifying the motivation tools and, implicitly, of involving each actor in activities aimed at increasing the quality of the educational and scientific offer of the institution is facilitated.

At the same time, it is important to emphasize the need for an individual approach to stakeholders, i.e. their correct systematization for each separate institution. This reasoning is based on the idea that, along with the existence of common stakeholders, such as, for example, the National Agency for Quality Assurance in Education and Research, depending on the industry orientation, each institution has also its specific stakeholders, such as the relevant ministry, certain research institutions, producers' associations, industry/sectoral agencies etc.

The role of stakeholders for higher education being recognized, we also need to mention the numerous problems related to their involvement in the life of the institution. So, while the educational institution can benefit immediately from the results of cooperation with most of the stakeholders, they, in turn, do not have instant effects. As a result, there are often difficulties in engaging them in cooperative activities [10]. On the other hand, the institution's efforts are not always sufficient and adequate, an initial difficulty being even the wrong, incomplete perception of the stakeholders by the representatives of the educational institutions. The last reasoning is argued by the results of the opinion survey conducted at the State Agrarian University of Moldova on a sample of 103 respondents. The structure of the total sample is shown in Figure 2, it's representativeness being represented in Table 1.

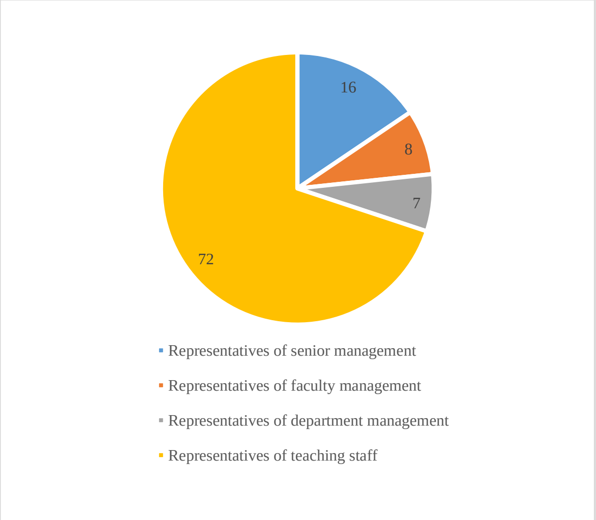

Fig. 2. The structure of the sample included in the opinion survey conducted at the State Agrarian University of Moldova
Source: Developed by the authors.

Based on the data in Table 1, we find that if the average representativeness of the sample is 42%, the coefficient of representativeness varies by categories of respondents. Thus, the highest representation is attested by the category of senior managers, this being 88%, while the representation of teaching staff is only 38%.

Table 1. Representativeness of the sample of the opinion survey conducted at the State Agrarian University of Moldova

Categories of respondents	Number of SAUM staff in the respective category, pers.	Number of respondents in the respective category, pers.	Represen-tativeness coefficient,%
Senior management	8	7	88
Faculty management	12	8	67
Department management	13	7	54
Teaching staff	214	81	38
Total	247	103	42

Source: Developed by the authors.

Based on the above, we deduce as a research limitation - the low representativeness of the teaching staff in the composition of the researched sample.

The processing of the results of the opinion survey allowed a series of findings to be made. Thus, to the question: "What does the term 'stakeholder' mean to you?" only 34% were able to provide a more comprehensive answer, mentioning, as essential features, both the interest in educational services offered by the institution and the impact of stakeholders on quality and, implicitly, performance. The other respondents highlighted as a defining feature: influence on the quality of educational and scientific services - 41%; interest/benefit from the institution's offer – 17%; adoption of decisions regarding the employment of graduates –3%. 5% stated that they cannot formulate an exact definition of the university's stakeholders.

By generalizing the answers provided by the interviewees to this first question, we can appreciate the fact that almost half of the respondents are aware of the impact of stakeholders on the quality of the institution`s offer, this being a premise for efforts to involve them in increasing the quality. At the same time, the existence of a considerable number of university representatives who perceive stakeholders only through the prism of unilateral interest, as well as those who cannot provide a certain approach, denotes the presence of essential reservations to increase the quality of stakeholder relations.

To the question "Who do you consider to be the internal stakeholders of the university?" the majority of respondents (88%) offered relevant answers, highlighting students, teaching staff, the management team. 2% also mentioned the syndicate. However, 7% omitted the students, while 3% also mentioned the relevant ministry.

If the internal stakeholders are better known by the university representatives, when they were asked to highlight the external stakeholders, relatively larger lists were exposed only by 22%. Here we can appreciate the fact that employers are found in the answers of 99 out of 103 respondents. At the same time, the omission of important external actors by most respondents proves the low awareness of the impact they can have on the institution.

Being asked to rank the internal stakeholders by significance**,** only 36% placed the students on the first position. 34% consider that teachers represent the most important internal stakeholders, and 30% placed the management team on the first position. Being widely recognized the role of students as internal stakeholders, we consider a problem the non-recognition of their major significance as direct beneficiaries of the activities carried out by 64% of respondents.

The results of the ranking of external stakeholders by significance are the following: 85% placed employers on the first position, this being a correct approach; 9% placed the National Agency for Quality Assurance in Education and Research on the first position; 5 % placed the relevant ministry on the first position; 1% erroneously indicated students as the most significant external stakeholders. By comparing the quality of stakeholder perception by the representatives of the management team and the teaching staff, we find the following: a) while most of the representatives of the management team can give a relevant definition to stakeholders, the majority of the teaching staff representatives erroneously elucidate the respective concept; b) if the internal stakeholders are perceived relatively equally by both groups of respondents, the external stakeholders are better known by the representatives of the institutional management; c) the ranking of stakeholders is also imposed by differences between the two groups of respondents. Thus, while most of the representatives of the management team consider the students the most important internal stakeholders, almost half of the interviewed teachers give priority to the institutional administration. At the same time, we can positively appreciate that both groups of respondents considered employers as the most important external stakeholders of the institution. The differences found in the perception of stakeholders by both groups of respondents are elucidated in Figure 3.

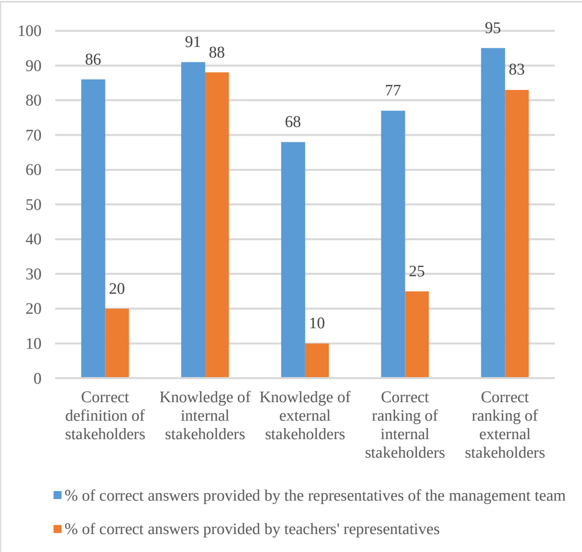

Fig. 3. Comparative analysis of the correctness of the perception of the stakeholders by the representatives of the management team and of the teaching staff in the State Agrarian University of Moldova
Source: Developed by the authors.

By generalizing the above, we deduce the following: having been identified a relatively large number of stakeholders of the State Agrarian University of Moldova, there are deficiencies in their correct perception by the internal actors of the institution. Thus, the inability of a considerable part of the respondents to reproduce the essence of stakeholders denotes an incomplete understanding of their significance in ensuring the performance of the institution. This conclusion is also argued by other errors made by respondents, in particular in identifying and prioritizing external stakeholders, which is a first sign of the insufficient involvement of the latter in the university activities.

The differences found in the quality of stakeholder perception by the two groups of respondents, in turn, prove the existence of greater deficiencies in teacher involvement in cooperative activities with stakeholders. Based on the reasoning that teachers are the ones who contribute directly to the transfer of the labor market requirements in the content of study programs and, respectively, in the competencies of future specialists, we consider that this issue requires immediate intervention.

CONCLUSIONS

Stakeholder mapping is required as a relevant and effective tool for identifying all stakeholders in the activities of vocational institutions which, in turn, determine, directly or indirectly, their performance and sustainability. Applying stakeholder mapping is an early stage in establishing an effective system of collaborative relationships with all stakeholders.

As a result of mapping the stakeholders of the State Agrarian University of Moldova, there were identified four actors of the institution's microenvironment, four actors of the macro environment and three categories of actors who, by virtue of their broad attributions and responsibilities, simultaneously refer to the microenvironment and macro environment. The classification of stakeholders by categories creates the necessary premises for establishing the relationship with a wider range of actors, for identifying the certain way of collaboration with each one, as well as for the opportunities to benefit from the results of the synergy of their efforts.

Despite the existence of numerous studies on the stakeholders of higher education institutions, and also of the growing need for optimal use of stakeholders to ensure an adequate quality of educational and scientific performance, there is a number of problems at the level of perception of stakeholders by the representatives of the State Agrarian University of Moldova, namely: a) insufficient knowledge of external

stakeholders; b) insufficient awareness of the need to focus on students, as the most significant internal stakeholders; c) the existence of gaps between the level of perception of the stakeholders by the representatives of the management team and of the teaching staff, fact that denotes the insufficient involvement of the teaching staff in the cooperation with stakeholders.
Based on the above findings, we can deduce that more actively promoting the value of stakeholders is an important initial step towards strengthening a strategic management of stakeholders. Implicitly, we can mention the need for more active involvement of the teaching staff in collaboration with external stakeholders, the latter being those who directly contribute to the transposition of the labor market requirements into vocational education`s outcomes.

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AN ELECTRICAL ROTARY CAGE ATOMIZER FABRICATED FOR SPRAYING ORCHARD

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Abstract

The environmental contamination due to off-target deposition of pesticide droplets can be minimized by using optimum design and operating parameters of sprayers. The fabricated electric rotary cage atomizer manufactured from the following component, rugged stainless steel welded frame with protective air intake grate, the center axial fane, high strength fiberglass protective and DC electric motor. The motor rotating speed was 3500 rpm. The liquid distribution system consisted of a metal liquid feed channel with holes leading to a series of grooves on the insides of the vanes between the slots. The open-ended design allowed the cage to act as a small centrifugal fan. This paper describes a collaborative theoretical and experimental research effort to investigate the performance of developed electric rotary cage atomizer utilized in agricultural field specially to spray orchards. A three-dimensional computational fluid dynamics (CFD) model was developed and used to evaluate concepts of rotary cage atomizer sprayer setup to orchard spraying to reduce drift without a decrease in biological efficacy. The result indicated that the maximum power requirement for single and two rotary cage spryer atomizers were 29.76 W and 55.2 W at rotational speed 3,500 rpm respectively. The maximum air velocity was recorded 5.3 ms-1 at out let distance 20 cm and rotational speed 3,500 rpm. The values of droplet size D0.5 were 251.72 at operating condition 0.4 L min^{-1}, 1,500 rpm and 0.5 ms^{-1} air velocity compared with droplet size D0.5 80.23 at operating condition 1.4 L min^{-1}, 3,500 rpm and 5.3 ms^{-1} air velocity. The increasing of the air velocity (U), rotational speed (Ω) and liquid flow rate tends to decrease the droplet size D0.25, D0.5, and D0.75. The values of droplet size D0.5 were 251.72 at operating condition 0.4 L min^{-1}, 1,500 rpm and 0.5 ms^{-1} air velocity compared with droplet size D0.5 80.23 at operating condition 1.4 L min^{-1}, 3,500 rpm and 5.3 ms^{-1} air velocity.

Key words: *electric rotary cage, atomization, sprayer*

INTRODUCTION

Egypt Washington navel orange (*Citrus sinensis* L. Osbeck) is one of the most important species in the genus citrus and ranked first among the species of citrus. It occupies about 35 % of the total cultivated area of citrus, since its acreage reached about 79,426 ha with total production of 1,663,284 tons per year according to the last census, issued by Ministry of Agriculture, Egypt (2015) [1]. Egypt is one of the world's leading orange producers and exporters. The orchard row middles typically require mowing several times per year to provide access through the planting for workers and equipment, to reduce vole habitat, and to reduce moisture in tree canopies. Air-assisted sprayers use air jets to carry pesticide droplets to the target position, to displace the air inside the crop canopy and to assist a uniform deposition of the pesticide droplets on the targeted surface. Preliminary data in demo trials suggest that this setup reduces drift without decreasing the biological efficacy. The use of modelling is an alternative to the expensive and difficult experimental and field measurements and provided a model for the droplet impact and deposition on crops [10]. In addition, [11] found that a spray of almost uniform droplet size is formed when liquid is fed onto the center of a spinning disk, and centrifuged off the edge in droplet form. They reported that the mean droplet size can be correlated with operating parameters by the following equation:

$$d_{\mathrm{vmd}} = K_1 \left(\frac{\sigma}{\rho D \omega^2} \right)^{0.5}$$

Fraser and Eisenklam (1956) [2] reported that the mean diameter of spray droplets can be correlated with operating variables for rotary disk atomizers as:

$$d_m = 3.8 \left(\frac{\sigma}{\rho D \omega^2} \right)^{0.5}$$

Reley (1959) [5] used flat spinning disks with different diameters, rotational speeds, and flow rates to obtain uniform droplet sizes. He correlated Sauter mean diameter (d32) with operating variables as follows:

$$d_{32} = K\sigma^{1.35} Q^{0.19} \rho^{-0.06} \omega^{-1.41} D^{-0.66} \mu^{-1.48}$$

Kayano and Kamiya (1978) [4] developed a correlation for the mean droplet sizes produced by a rotating disk as:

$$d_{32} = 2.0\, D^{-0.69}\, \omega^{-0.79}\, Q^{0.32}\, \mu^{0.65}\, \sigma^{0.26}\, \rho^{-0.29}$$

The objectives of the current research were manufactured and evaluated an electric rotary cage atomizer sprayer for orchards tree. As well as using the theoretical model to predicate the droplet size from the fabricated rotary cage atomizer. Also, the goal of this investigation is to produce a validated theoretical model capable making timely predictions of atomizer performance.

MATERIALS AND METHODS

The current research conducted in Agricultural Engineering dept., faculty of agriculture, Kafrelsheikh University, Egypt during session 2018/2017. The rotary cage atomizer or controlled droplet applicator (CDA) has been used for years in aerial application but is a relative new device for ground application [6]**.** The rotary cage atomizer nozzles form the spray by using centrifugal force at a rotating disk of wire cage rather than forcing the liquid through a nozzle orifice. The fabricated electric rotary cage atomizer manufactured from the following component, rugged stainless steel welded frame with protective air intake grate, the center axial fane, high strength fiberglass protective and DC electric motor. The motor rotating speed was 3,500 rpm. The liquid distribution system consisted of a metal liquid feed channel with holes leading to a series of grooves on the insides of the vanes between the slots. The open-ended design allowed the cage to act as a small centrifugal fan. Figure 1 indicates the construction of developed an electric rotary cage atomizer unit. The rotary cage atomizer was operated from 1,500 rpm to 3,500 rpm by increasing of 500 rpm. The flow-rate was increased from 0.4 l/min to 1.2 l/min by steps of 0.2 l/min corresponding to water acceptable volume rate 100 l/ha at forward speed ≈ 5 km/h and working width in orange trees when using two rotary cage atomizers in the completely prototype sprayer as shown in Figure 2. The air velocity was measured at different out let distance from rotary cage atomizer without liquid. The anemometer was fixed at 0.18 m from the center of rotary cage atomizer and at different out let distance (from 0.2 m to 1.2 m by increasing of 0.2 m). All measuring data were collected and analyzed.

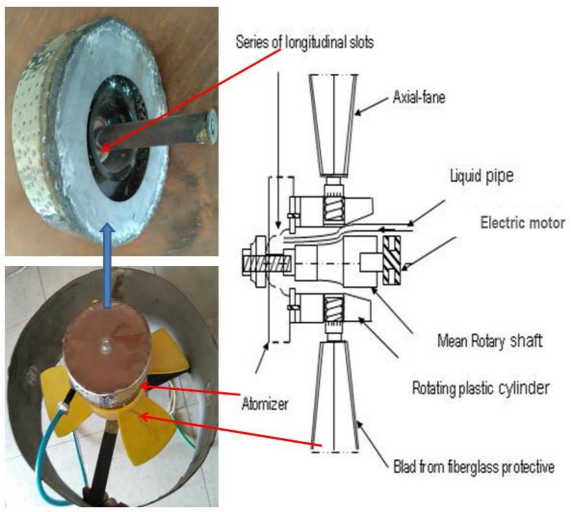

Fig. 1. The diagram of fabricated an electric rotary cage atomizer
Source: Authors' own illustration.

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Power source of the development electric rotary cage atomizer

The dry battery is very sensitive in the charging and needs a special charger to control the charging. The charger delivers 10 A to the battery. When a dry battery is discharged 80% and only 20% capacity is left in the battery, the overall lifetime of the battery (if not recharged at this point) is reduced a lot. This means that the battery will last longer if it is recharged with 20% capacity left. The battery can get destroyed if the battery is more than 90% discharged. This means that the battery only has to charge 80% of the 70 Ah. The chargeable time of this battery could be calculated as follow: 70Ah·0.8/10Ah/hour = 5.6 hours. The battery chargeable time 5.6 hours presupposes that the battery is 100% efficient at absorbing the charge. The battery is charged with a charge controller and the reduction of power battery (BPR) has to receive as follow:

BPR = (1-E2*I2 /E1*I1**)** as mentioned [7]

where:

BRP is the reduction power rate of battery,

E_1 is the voltage at start operation and

E_2 is the voltage after 15 min, 30 min, 45 min and one hour operation.

The I_1 and I_2 value is the electric current with ampere measured at start and during the operating time respectively.

The inverter model Deka 1,500 converted the 0.12 kW DC power to 1.32 kW AC power to operate the Turbo QB60 hydraulic pump with power 0.37 kW. As well as the elapsed time was recorded at 80 % from the battery efficiency to start the rechargeable. The multi-meter MS 345 was used to measure the power consumption directly from the inverter Deka1500 [7], [8].

Test procedure and laboratory test

The electric power from the tractors' dry battery was evaluated to operate the weeder DC motor.

The battery remaining rated and capacity was measured by using the Tektronix Oscilloscope Model TPS 2024.

State of Charge (SOC) is defined as the remaining capacity of a battery and it is affected by its operating conditions such as load current and temperature. SOC is a critical condition parameter for battery management. Accurate gauging of SOC is very challenging, but the key to the healthy and safe operation of batteries. The SOC determined by the following formula:

SOC= (Remaining capacity/Rated capacity) according to [9] , [12].

The testes for operation the electric rotary cage atomizer depending up on the dray battery that charged by the tractor generator was 5 minutes for every trail.

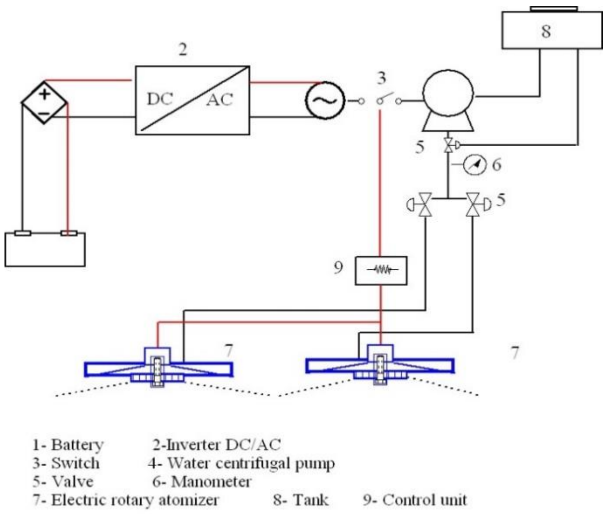

Fig. 2. Two rotary cage atomizers in the completely prototype sprayer with electricity circuit and water line.
Source: Authors' own illustration.

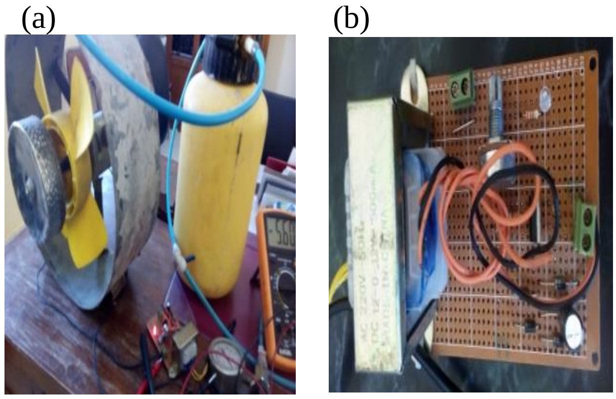

Fig. 3. The rotary cage atomizer test (a) in laboratory and electricity circuit control unit for rotational speed and power requirement (b).
Source: Authors' own illustration.

Fan outlet velocity

The measurement of this air velocity at the fan outlet was done in a laboratory room of 20 m long and 8 m wide. Based on measured values in the experimental room, an air temperature of 23 ◦C and relative humidity of

74% were used. A steady state simulation with a moving coordinate system (the speed equal to the ground speed of the tractor) was implemented.

Spray atomization model

The theoretical model to predicate the droplet size from the fabricated rotary cage atomizer was developed correlations for mean droplet size produced by air shear rotary cage atomizers are studied by [3]**.**The following equation cited by Hewilt was used to predict the droplet size under all rotational speed of the developed electric rotary cage atomizer and their operating conditions:

$$D_{V0.25} = 28.122\left(\frac{U}{U_{max}}\right)^{-0.331}\left(\frac{Q}{Q_{max}}\right)^{0.103}\left(\frac{\Omega}{\Omega_{max}}\right)^{-0.992}$$

$$D_{V0.5} = 50.258\left(\frac{U}{U_{max}}\right)^{-0.327}\left(\frac{Q}{Q_{max}}\right)^{0.056}\left(\frac{\Omega}{\Omega_{max}}\right)^{-0.714}$$

$$D_{V0.75} = 67.129\left(\frac{U}{U_{max}}\right)^{-0.359}\left(\frac{Q}{Q_{max}}\right)^{0.068}\left(\frac{\Omega}{\Omega_{max}}\right)^{-0.706}$$

where:

U_{max} = 6 m s^{-1}, Q_{max} = 5 L min^{-1}, and Ω max = 3,500 rpm, were submit in the above equation to estimate the droplet size.

The R^2 = 0.964, 0.962, and 0.978, respectively. The arithmetic diameters of the droplets of the droplets were computed directly from the raw measurements using MATLAB (Mathworks, Natick, MA).

RESULTS AND DISCUSSIONS

The result of the measuring laboratory tests indicated that the power requirement for developed single and two rotary cage atomizers was illustrated in Figure 4. The maximum power requirement for single and two rotary cage spryer atomizers were 29.76 W and 55.2 W at rotational speed 3,500 rpm respectively. Also, increasing the rotational speed tends to increase the power requirements for developed electric rotary cage atomizer.

Figure 5 indicated that the relation between the out let distance and produced air velocity from developed electric rotary cage atomizer under different rotational speed. The increasing of out let distance gave the low air velocity under all test rotational speed conditions. The maximum air velocity was recorded 5.3 ms^{-1} at out let distance 20 cm and rotational speed 3,500 rpm. As well as the mean value of air velocity was 4.3 ms^{-1} at out let distance 60 cm. This value is the indicator of the velocity droplet size produced from the developed electric rotary cage atomizer into the target or orchards. It could be able to operate the electric rotary cage atomizer to produce different droplet velocities. This result may be utilized for different orchards to spray. As well as it is essay to control the droplets and air velocities by changing the power sources of the rotary cage atomizer using the manufactured control unit. Also, their maintenance will be able and very chip compared with hydraulic rotary cage atomizer.

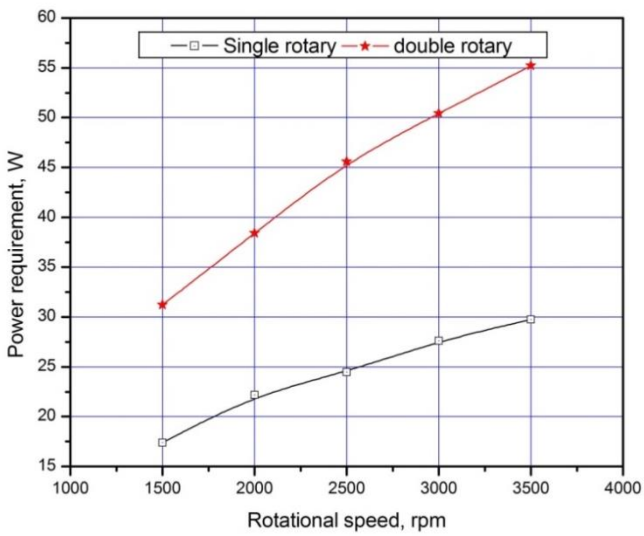

Fig. 4. The power requirement for single and two electric rotary cage atomizer at different rotational speed.
Source: Authors' determination.

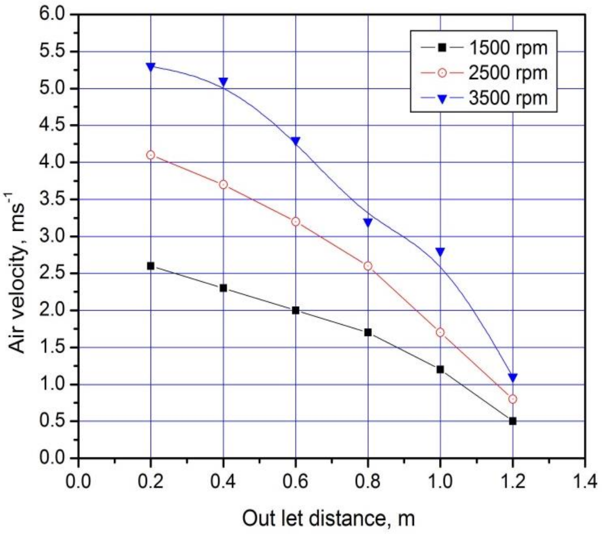

Fig. 5. The produced air velocity from single developed electric rotary cage atomizer at different rotational speed.
Source: Authors' determination.

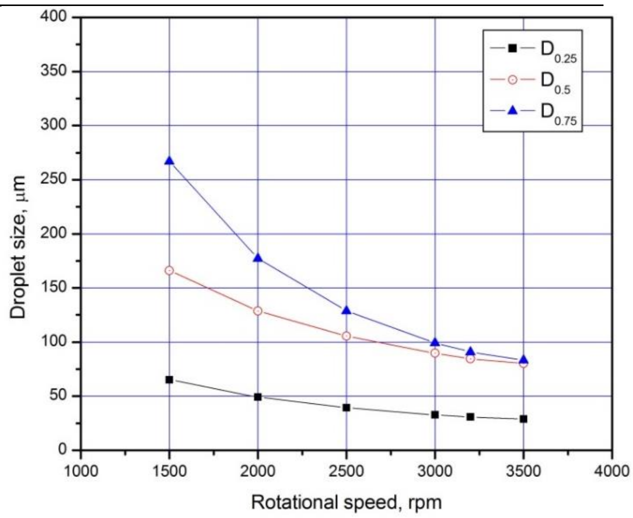

Fig. 6. The droplet size predicted of developed electric rotary cage atomizer at different rotational speed at maximum air velocity 5.3 ms^{-1} and maximum flow rate 1.4 l min^{-1}.
Source: Authors' determination.

Result of the theoretical model to predicate the droplet size

The result of the predicted droplet size $D_{0.25}$, $D_{0.5}$, and $D_{0.75}$ listed and indicated in Figures 6 and 7 and table 1 and 2. The increasing of rotational speed tends to decrease the volume medium diameter $D_{0.5}$, and droplet size $D_{0.25}$, and $D_{0.75}$. The model may able to study the effect of the rotational speed of electric rotary cage atomizer, flow rate and air velocity produced in air assisted sprayer. Figure 5 display the effect of different rotational speed at maximum air velocity 5.3 ms^{-1} and maximum flow rate 1.4 l min^{-1} on the droplet size predicted of developed electric rotary cage atomizer. The values of $D_{0.25}$, $D_{0.5}$, and $D_{0.75}$ were 66.17, 166.07 and 266.91µm at rotational speed 3,500 rpm respectively. Also, Figure 6 display the effect of different rotational speed at low air velocity 0.5 ms^{-1} and maximum flow rate 0.4 l min^{-1} on the droplet size predicted of developed electric rotary cage atomizer. The values of $D_{0.25}$, $D_{0.5}$, and $D_{0.75}$ were 125.32, 251.72 and 364.39 µm at rotational speed 1,500 rpm respectively. It noticed that, it could be able to produce different droplet spectrum from electric rotary cage atomizer and may be used in different application not only in agricultural field.

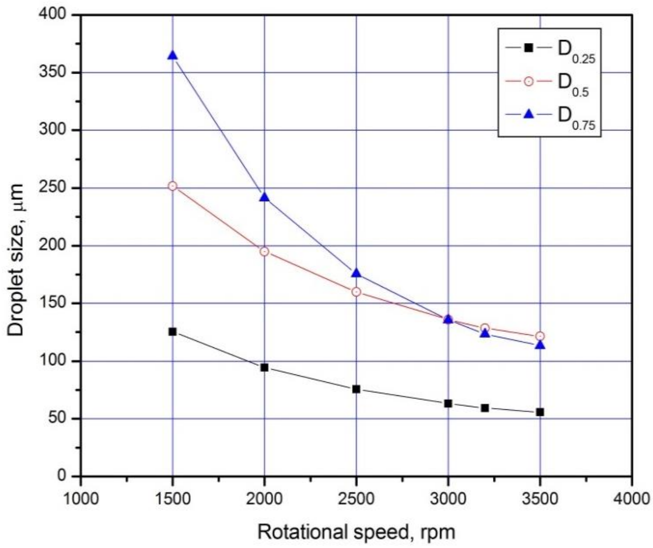

Fig. 7. The droplet size predicted of developed electric rotary cage atomizer at different rotational speed, low air velocity 5.3 ms^{-1} and low flow rate 1.4 l min^{-1}.
Source: Authors' determination.

Table 1 indicated the predicted values of droplet size under different operating conditions. The increasing of the air velocity (U), rotational speed (Ω) and liquid flow rate tends to decrease the droplet size $D_{0.25}$, $D_{0.5}$, and $D_{0.75}$. The values of droplet size $D_{0.5}$ were 251.72 at operating condition 0.4 L min^{-1}, 1,500 rpm and 0.5 ms^{-1} air velocity compared with droplet size $D_{0.5}$ 80.23 at operating condition 1.4 L min^{-1}, 3,500 rpm and 5.3 ms-1 air velocity.

Table 2 displayed the values of droplet size $D_{0.25}$, $D_{0.5}$, and $D_{0.75}$for maximum and minimum rotational speed at different trails operating conditions.

Table 1. The predicted values of droplet size under different operating conditions

$D_{0.75}$	$D_{0.5}$	$D_{0.25}$	Ω, rpm	Q, l m^{-1}	U, ms^{-1}	Ω_{max}	Q_{max}	U_{max}
341.39	251.72	107.32	1,500	0.4	0.8	3,500	1.4	5.3
215.17	170.36	73.52	2,000	0.6	1.2	3,500	1.4	5.3
146.37	126.98	51.23	2,500	0.8	2	3,500	1.4	5.3
110.98	100.27	41.76	3,000	1	2.3	3,500	1.4	5.3
95.01	89.12	34.09	3,200	1.2	3.7	3,500	1.4	5.3
85.50	80.23	31.02	3,400	1.4	4.3	3,500	1.4	5.3

Source: Own results.

Table 2. Display the values of droplet size $D_{0.25}$, $D_{0.5}$, and $D_{0.75}$for maximum and minimum rotational speed at different trails operating conditions

Trail	**$D_{0.25}$**	**$D_{0.5}$**	**$D_{0.75}$**	**air speed, ms^{-1}**
flow 1.4 l/min rotational speed 3,500	61.58	78.19	110.21	0.5
	46.05	78.19	97.74	1.2
	38.87	78.19	91.12	2
	37.1	78.19	89.39	2.3
	30.14	78.19	82.04	4.3
	28.12	78.19	79.72	5.3
flow 0.4 l/min rotational speed 1,500	0.5	125.44	251.72	364.13
	1.2	93.8	251.72	322.92
	2	79.17	251.72	301.06
	2.3	75.58	251.72	295.34
	4.3	61.4	251.72	271.05
	5.3	57.28	251.72	263.38
				Flow rate, $Lmin^{-1}$
air velocity 5.3 and rotational speed 3,500	0.4	24.72	118.52	78.67
	0.6	25.77	103.59	79.01
	0.8	26.55	94.15	79.25
	1	27.16	87.43	79.43
	1.2	27.68	82.3	79.59
	1.4	28.12	78.19	79.72
air velocity 0.5 and rotational speed 1,500	0.4	125.44	251.72	364.13
	0.6	130.79	220.01	365.7
	0.8	134.72	199.97	366.82
	1	137.86	185.69	367.69
	1.2	140.47	174.79	368.4
	1.4	142.72	166.07	369

Source: Own results.

CONCLUSIONS

It could be summarized that the increasing the rotational speed tends to increase the power requirements for developed electric rotary cage atomizer. As well as it is essay to control the droplets and air velocities by changing the power sources of the rotary cage atomizer using the manufactured control unit. Also, their maintenance will be able and very cheap compared with hydraulic rotary cage atomizer. The increasing of rotational speed tends to decrease the volume medium diameter $D_{0.5}$, and droplet size $D_{0.25}$, and $D_{0.75}$. The model may able to study the effect of the rotational speed of electric rotary cage atomizer, flow rate and air velocity produced in air assisted sprayer. The developed rotary cage atomizer could be able to produce different droplet spectrum and may be used in different application not only in agricultural field.

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SOCIO-ECONOMIC ANALYSIS OF RURAL TOURISM DEVELOPMENT: CASE STUDY IN UKRAINE

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Abstract

The article considers the current state and prospects of rural tourism development in Ukraine. The analysis of scientific sources of Ukrainian and foreign scientists, relating to the subject of this study, is made. The article contains personal research conducted in 2020. Based on the data of a sociological survey on the attitude of Ukrainian citizens to the development of rural tourism in Ukraine, the willingness of the population to rest in rural area and invest their own funds in the development of private business in this area was analyzed. Attention is paid to obstacles to the development of rural tourism and the main ways that will promote the development of rural tourism in Ukraine.

Key words: *rural tourism, rural area, Ukraine, tourism industry, socio-economic analysis.*

INTRODUCTION

Today, rural tourism is an important component of the tourism industry in the broadest sense of this term. In the countries of the European Union, rural tourism covers more than 30% of used holidays. As a way to spend free time it is chosen for the second or third time during the year [5]. Rural tourism in Europe has a long tradition. It is in him that the European Union sees the main lever for the economic recovery of its rural areas [4].

Today the rural tourism in Ukraine is in the formation stage. The development of this sphere of tourist services in rural areas has begun to acquire a systemic character from the end of the twentieth century. The rest in the picturesque villages through the use of the available private housing stock of hospitable hosts has a positive effect not only on the health of vacationers, but also on the environment and the economy of the regions of Ukraine. This in turn expands the scope of employment of rural residents and allows the sale of environmentally friendly products of personal farming [3, 9].

The picturesque Ukrainian village has a unique historical and architectural heritage, curative and recreational resources, original culture and way of life, unique landscapes, rich national traditions, opportunities to eat ecologically clean products and relax in the conditions of charming nature. Due to the COVID-19 pandemic, the development of rural tourism in Ukrainian villages is becoming increasingly popular among tourists.

Rural tourism is a promising way of sustainable development in rural area. After all, it is an effective means of combating poverty and solving a number of social, economic and environmental problems of the Ukrainian village. World practice shows the high profitability of sphere of rural tourism. According to the sociological surveys conducted in the European Union, the three main motives for choosing rural tourism services are: the "escape" from the intense pace of urban life, the possibility of immersion in rural life, relaxation (35.2%); the possibility of combining recreation with active travel (20.2%); the desire to relax in nature and communicate with the world of plants and animals (17.3%) [8].

Today in Ukraine rural tourism does not have a sufficient legal basis. It is considered in the Law of Ukraine "On Tourism" [13] only as a type of tourism and does not contain a clear definition. The right of peasant farms to engage in rural tourism is defined by the Law of Ukraine "On Individual Farm". This law gives a definition of the personal peasant economy and outlines the scope of this activity. It is also noted that the activities related with the conducting personal peasant farms are not related to the entrepreneurial activity [14].

World Tourism Organization understands Rural Tourism as a type of tourism activity in which the visitor's experience is related to a wide range of products generally linked to nature-based activities, agriculture, rural lifestyle/culture, angling and sightseeing [12].

The benefits of rural tourism development (economic, environmental and socio-cultural) are discussed in the research of Tsephe and Eyono Obono. The aim of the study was to develop a model of factors influencing the motivation of tourists to rest in rural areas [11].

The attitude of local residents to the development of sustainable tourism in rural area and the impact of tourism development on rural area were studied by Muresan et. al. According to the respondents, the positive advantages of rural tourism development are: the ecological component of sustainable development, the possibility of employment, improving the quality of life of local residents, improving the overall infrastructure of villages and others. The local community is ready to support the sustainable development of tourism with significant benefits (economic, socio-cultural and infrastructural) [7].

Studies conducted by Blešić et. al. concerned villages where tourism is just beginning to develop. The purpose of the survey was to analyze the attitude of the population to the development of tourism in rural area. The results of the survey showed that respondents are aware that with the development of rural tourism in rural area there will be both advantages and certain problems. In addition, respondents agree that tourism activities in the region will bring economic benefits. The analysis of respondents answers also showed that residents assessment of economic and socio-cultural impact differs significantly depending on their socio-demographic characteristics. The results of the study confirmed the idea that explaining to villagers the importance of the potential benefits of rural tourism development is essential for the successful functioning of this area [1].

Dimitrovski at. al. highlights the main benefits of rural tourism development for villagers. These include: preservation of the environment and cultural heritage, economic benefits for the local population, prevention of migration from villages to cities, diversification of the rural economy, improvement of local infrastructure, etc. [2].

The purpose of the article is to study the attitude of the population of Ukraine to the development of rural tourism. Based on the data obtained, identify the main advantages and obstacles that exist in this area. Propose specific measures for the successful functioning of rural tourism in Ukraine.

MATERIALS AND METHODS

In the process of writing the article we used general and special scientific research methods: generalization – for research the essence of the concept of "rural tourism"; comparative analysis – in the study of foreign experience on the impact of rural tourism on rural area; sociological survey – to collect sociological information; graphic method – for plotting diagrams; induction and deduction – to summarize the results of the study and formulate conclusions.

To analyze the state of awareness and attitude of the population of Ukraine to the development of rural tourism in Ukraine, we conducted a survey among citizens living in all regions of Ukraine. Our purpose was to find out whether the population of Ukraine wants to develop such perspective type of tourism as rural tourism.

We developed a survey questionnaire containing 14 questions. Respondents were asked to choose one or more of the suggested answers or to indicate their own option. Respondents were also asked to provide general information about themselves, which included: gender, age, education, place of residence and average monthly family income per person. The survey was conducted during August-December 2020. Form of conducting – online survey in the Google Forms system.

A total of 326 respondents took part in the survey.

Differences in the historical development of Ukrainian territories, their natural conditions and natural resource potential, ethnocultural and socio-demographic features, different levels of economic development, their economic specialization and economic structure of the territories led to the formation of economic regions of Ukraine. Each economic region has a certain territory, its own internal economic structure, mechanisms of management and functioning [6]. Maniv et.al. identify the most stable and functional-operational structure of economic regions in Ukraine, which includes 8 economic regions: Donetsk (Donetsk and Luhansk regions), Prydniprovsk (Dnipropetrovsk, Zaporizhia and Kirovohrad regions), Eastern (Poltava, Sumy and Kharkiv regions), Central (Kyiv, Cherkasy regions), Polissya (Volyn, Zhytomyr, Rivne and Chernihiv regions), Podilsky (Vinnytsia, Ternopil and Khmelnytsky regions), Carpathian (Zakarpattia, Ivano-Frankivsk, Lviv and Chernivtsi regions), Black Sea (Odessa, Mykolaiv and Kherson regions and the Autonomous Republic of Crimea) [6]. We used this method of dividing Ukraine by its regions to analyze the perspectives for the development of rural tourism in Ukraine.

RESULTS AND DISCUSSIONS

The obtained results of the sociological survey are presented in this section of the work. This part of the article contains an analysis of the questionnaire and a graphic illustration of the results. Respondents general perception of the development of rural tourism in Ukraine was assessed by choosing one or more of the proposed answers to the proposed questionnaire.

326 respondents took part in the survey, including 62% of women and 38% of men. The majority of the respondents live in an urban area – 67%, 25% of respondents live in rural area and 8% of respondents live in urban village area. Respondents aged: 18-25 years – 22%; 26-35 years – 36%; 36-45 years – 25%; 46-59 years – 13%; 60 years and older – 4%. The largest share of respondents are citizens with higher education – 67%, 14% of respondents have a scientific degree, 11% of respondents – people with incomplete higher education, 6% of respondents have secondary special education and 2% of citizens have completed secondary education (Fig. 1).

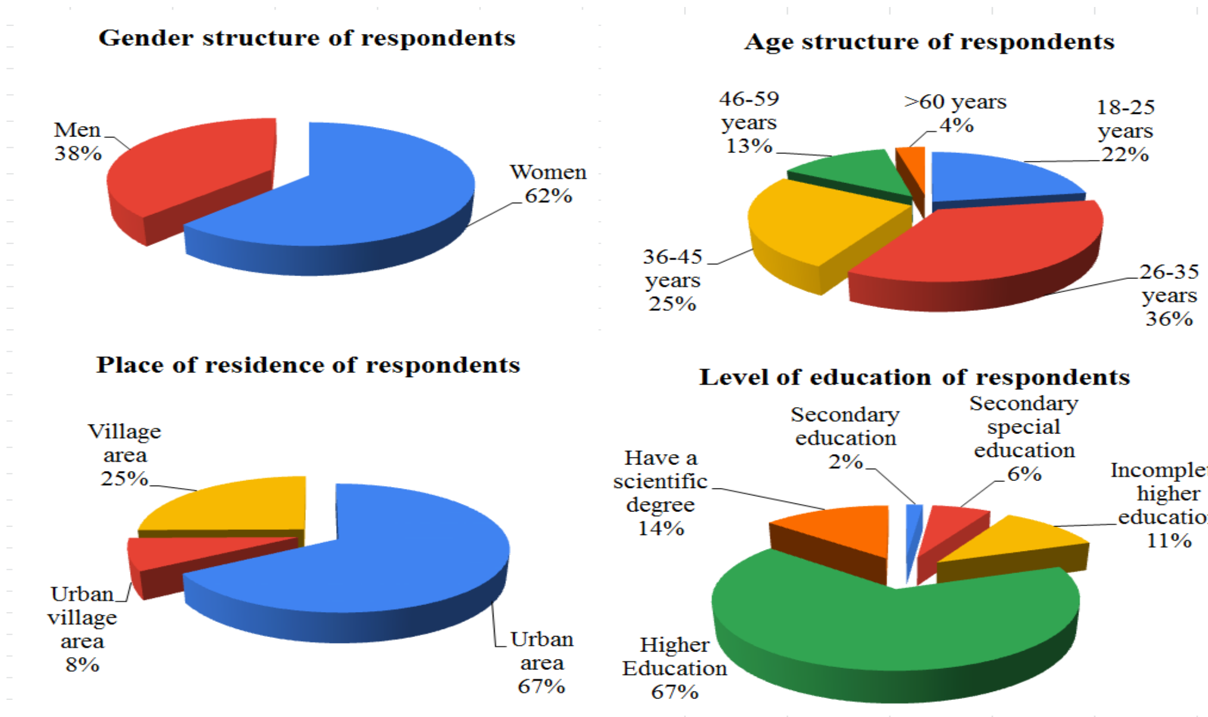

Fig. 1. Socio-demographic characteristics of the respondents
Source: own representation.

The population of Ukraine differs significantly by income level, depending on the place of residence and social status. Among the surveyed citizens, the largest share (47%) were respondents, whose average monthly family income per person was more than 6,000 UAH (as at January 2021). In 30% of respondents this income is in the range from 4,000 to 6,000 UAH, in 17% of respondents – from 2,000 to 4,000 UAH, and in 6% of respondents this income is very small – up to 2,000 UAH. Different numbers of respondents were interviewed in the regions of Ukraine. The largest share of respondents (47%) live in the Carpathian region, 16% – in the Central region, 11% – in the Prydniprovsk region, 9% – in the Polissya region, 6% – in the Eastern region, 5% – in the Black Sea region, 4% – in the Podilsky region and 2% – in the Donetsk region (Fig. 2).

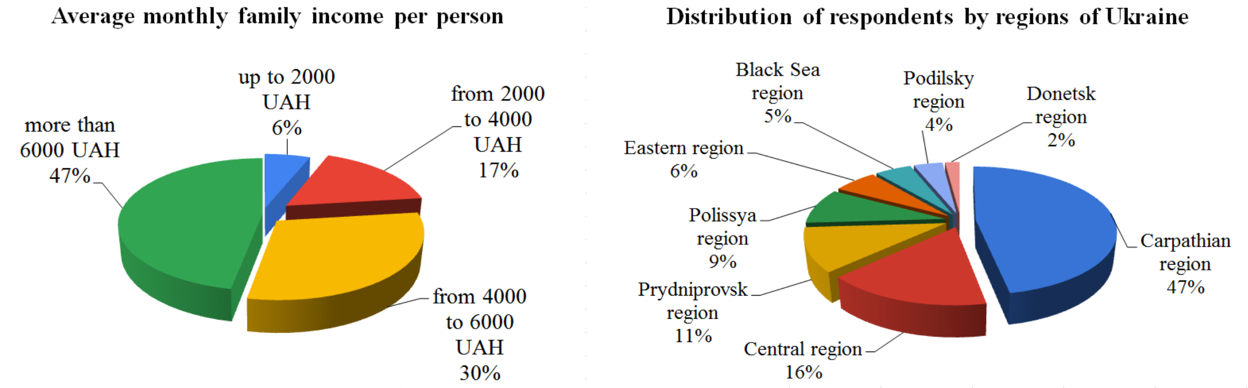

Fig. 2. Distribution of respondents by income level and regions of Ukraine
Source: own representation.

The socio-economic survey shows that the recreation in rural area is liked by a significant proportion of respondents (92%).
We chose the five most attractive regions for recreation in Ukraine (according to data of the State Statistics Service of Ukraine [10]). 70% of respondents preferred to rest in the region of the Ukrainian Carpathians. We see that the Ukrainian Carpathians attract tourists from all over Ukraine with its picturesque nature, mountain landscapes, unique cultural and ethnographic heritage, rich natural and recreational resources, ancient traditions and folk rites, historical past and landmarks of architecture and art, which are known far beyond Ukraine. It is in the Carpathian economic region that the perspectives of the development of rural tourism remain one of the best in Ukraine, given the complex influence of various factors (historical, geographical, ethnographic, cultural, environmental, economic, social, etc.). A small proportion of respondents (13%) would like to rest in the Black Sea region, 8% of respondents are attracted to rest in the Central region of Ukraine, 6% of respondents want to rest in Polissya region and 3% – in Podilsky region (Fig. 3).

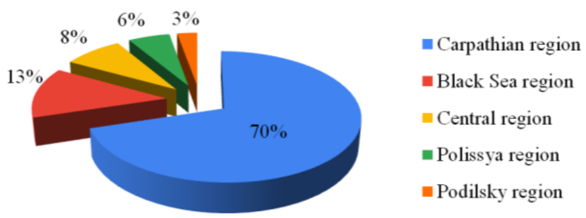

Fig. 3. Attractiveness of the regions of Ukraine for recreation in rural area
Source: own representation.

The majority of respondents consider that the main advantages of recreation in rural area are the picturesque landscapes and cozy atmosphere of the village (85%). The next position is occupied by hiking and horseback riding, picking berries and mushrooms, fishing (56%). 55% of respondents prefer to get acquainted with the local culture and way of life, national cuisine. Slightly fewer respondents rated the possibility of eating environmentally friendly products (44%), affordable cost of rest (42%) and curative and recreational resources of the area (37%) (Fig. 4). It is worth noting that the respondents were given the opportunity to choose one or more of the proposed answers or to indicate their own option.

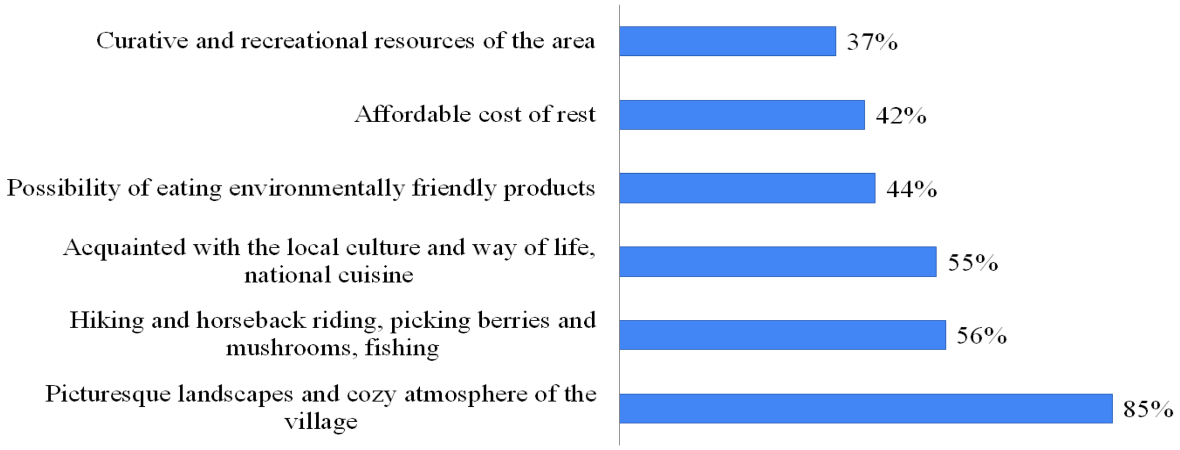

Fig. 4. The main advantages of recreation in rural area
Source: own representation.

It should be noted that 95% of respondents consider that the development of rural tourism in Ukraine is necessary. Our survey shows that 62% of respondents see the need to develop of rural tourism exactly in the unique historical and ethnographic heritage of Ukrainian villages, 53% of respondents – in the ecological purity of the rural area, 46% – in the traditional hospitality of the owners and affordable price for rest, 40 % of respondents – in the availability of free labor resources to serve tourists, 33% of respondents – in the availability of free rural housing for tourists, 32% of respondents preferred a variety of additional excursion services to the liking of tourist and 28% of respondents see the need for growing demand for recreation in rural area (Fig. 5).

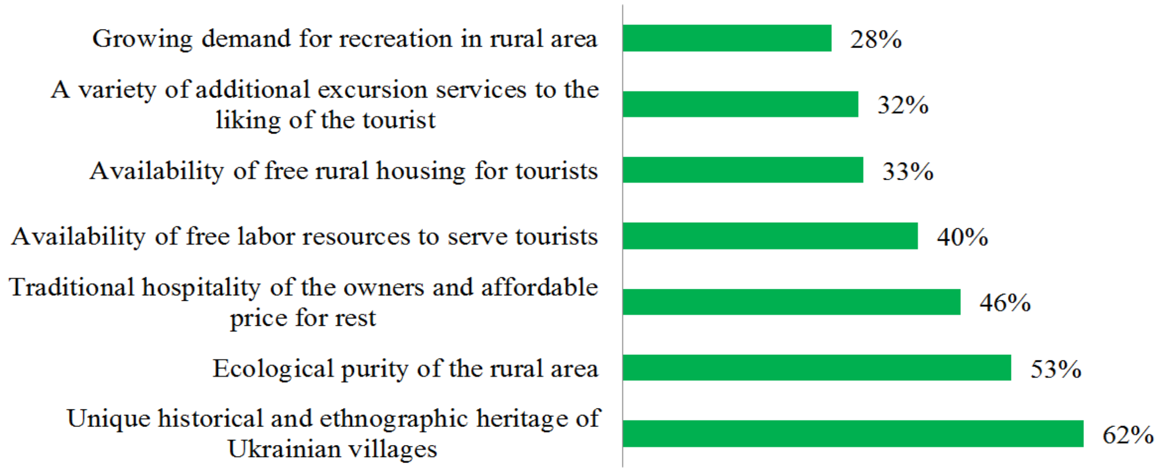

Fig. 5. The need for rural tourism development in Ukraine
Source: own representation.

The majority of respondents (82%) consider that for a clear economic and legal regulation of activity in the field of rural tourism, it is necessary first of all to accept the Law of Ukraine “On Rural Tourism” at the state level.

Today there are positive trends in the development of tourism in rural area inhibit some problematic aspects of the development of the tourism and recreation industry, the main of which are: unsatisfactory condition of tourist routes, inefficient use of existing transport to transport tourists, lack of visual tourism information, neglect of environmental safety rules in nature reserves and recreational areas, etc.

According to the respondents, the most important obstacles to the development of rural tourism in Ukraine are: insufficient state funding and lending (66%), difficult conditions for registration and business (47%), lack of legislative framework (39%), low qualification of tourism workers (35%) and another answer (14%). To another answer the respondents included: low level of advertising and promotion of rural tourism; lack of appropriate infrastructure; low income of citizens; the need to create places of interest for tourists (maintenance of old buildings in good condition, rather than damage them by modern repairs); lack of experience among entrepreneurs and poor dissemination of information about this type of tourism; ignorance of the population about the availability of rural tourism services and its benefits; lack of appropriate advertising; unsatisfactory condition of roads and problems with Internet connection; unwillingness to improve the available service; insufficient marketing measures to promote this type of tourism; pollution and unsatisfactory condition of certain territories, lack of initiative of citizens to open their own business in the field of rural tourism, etc. (Fig. 6).

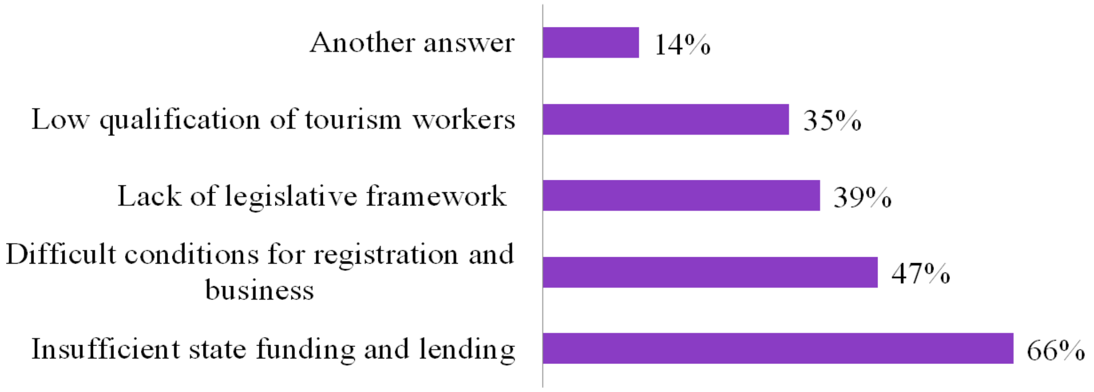

Fig. 6. Obstacles to the development of rural tourism in Ukraine
Source: own representation.

Respondents were also asked to rate between 1 and 4 points (1 – none, 2 – weak, 3 – satisfactory, 4 – appreciable) state efforts to promote the development of rural tourism. To this question, 50% of respondents said that the state does not make any efforts to develop rural tourism, 46% of respondents noted that the efforts are weak and only 4% believe that the state's efforts are satisfactory.

Regarding opening a private business in the field of rural tourism, the answers of the respondents were distributed as follows: 54% – would like to open, and 46% – wouldn't like. We also asked the respondents whether they are willing to take a bank loan to start a private business (if they do not have enough own funds), given that within 10-15 years this loan can be repaid on the basis of profits that will be received in the course of private business. The answers to this question were divided as follows: 66% – are not ready to take a bank loan, and 34% – are ready to take a loan to open and develop private business in the field of rural tourism.

When asked what percentage of own funds respondents are willing to invest in starting their own business in the field of rural tourism, the answers of the respondents were divided as follows: 53% of citizens answered that they are ready to invest 30% of their own funds, 25% of respondents are ready to invest 50% of their own funds, 10% of citizens are ready to invest 70% of their own funds, and 4% of respondents are ready to invest 100% of their own funds. Note that 8% of respondents indicated a different answer (namely: ready to invest another percentage of their own funds (10%, 20%; 45%; 85%); not ready to invest anything; ready to invest only their own funds, because they do not want to take a loan; consider the possibility of at least a small grant or benefits at the beginning of the development of their business (meaning a homestead for one family, a company of up to 6 people); some respondents did not answer the questions because they do not have information in the field of rural tourism).

Due to the existence of certain problems related to the development of rural tourism in Ukraine, the state must take a number of urgent measures. These measures should include: improvement of national legislation; approval of organizational conditions for the provision of services in the field of rural tourism; formation of proposals on the elements of corporate style and ethnic features of the identification of the Ukrainian estate; activation of local authorities to support rural tourism; training and preparation of qualified personnel who are able to implement new ideas, attract investments and carry out effective management of new projects, etc.

When asked how the state could help improve the situation in the field of rural tourism, 80% of respondents said that it is necessary to attract investors, 54% of respondents believe it is necessary to develop environmental and economic programs, 51% – the adoption of the Law of Ukraine "On Rural Tourism". And 11% of respondents indicated their own answer: development of village infrastructure and repair of existing roads leading to rural estates with appropriate road signs; the possibility of providing dotation; tax benefits; funding and promotion (advertising, PR); advertising support at all levels of the media; reduction tax pressure and reduction of unnecessary state control; encouraging young and middle-aged people, engaged in rural tourism, to live in rural area; control over observance of sanitary and hygienic norms; raising the level of qualification of service workers; popularization of own tourist products by territorial communities; creation of a favorable legal framework for the development of rural tourism, etc.) (Fig. 7).

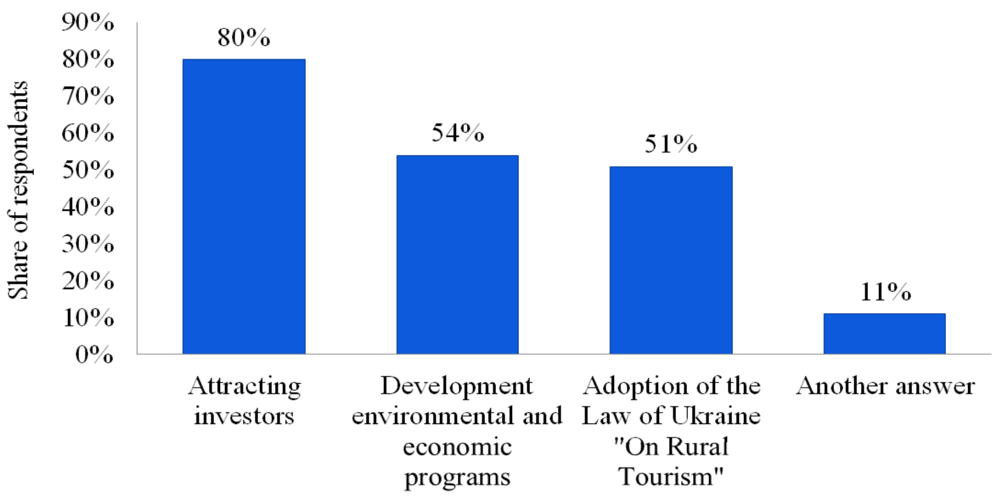

Fig. 7. Factors of state influence on improving the situation in the field of rural tourism
Source: own representation.

The development of quality rural tourism can lead to many positive changes in rural area. Among the surveyed respondents, 67% of citizens believe that attracting investment for the reconstruction of existing and creation of new tourist facilities is the most necessary factor. 64% of respondents believe that such a factor is an effective state policy in this area. 58% of respondents believe that the state should promote the development of promising tourist regions. 47% consider participation in international development programs a necessary factor, and 45% of respondents consider the implementation of economic and social projects. A small number of respondents (5%) provided a different answer (in particular: organization of training for owners of estates; bringing roads to proper condition; cleanliness of streets, reservoirs and adjacent territories; attracting Ukrainian investors, etc.) (Fig. 8).

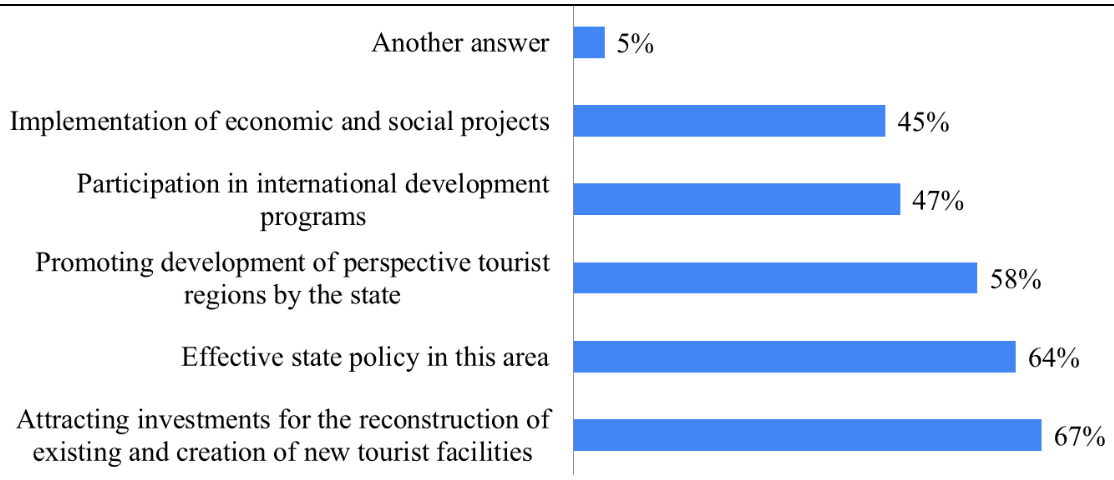

Fig. 8. Factors that contribute to the successful development of rural tourism
Source: own representation.

We asked how to stimulate demand for rural tourism in Ukraine (Fig. 9). 81% of respondents believe that good transport connection with rural estates are needed. 59% of respondents consider that low prices for accommodation and meals are the significant factor. 45% of respondents preferred a wide range of entertainment services. 34% of respondents said that the most important thing for them is to eat only environmentally friendly products. And 5% of respondents indicated their own answer: advertising; training of estate owners; good roads; Internet access; compliance of the provided services with European standards; information campaigns by government programs: on reservoirs – cleaning of reservoirs; in mountainous areas and forest belts – prevention of deforestation; in the Black Sea and Azov regions – the creation of recreation centers with a wide range of services inherent in this area; there should be a certain feature that would encourage people to relax in the area more than once; support of advertising and promotion of rural tourism services at the regional, state and international levels; improving the quality of services through training programs for owners of rural estates; organization of law enforcement in the fight against fraud and hooliganism.

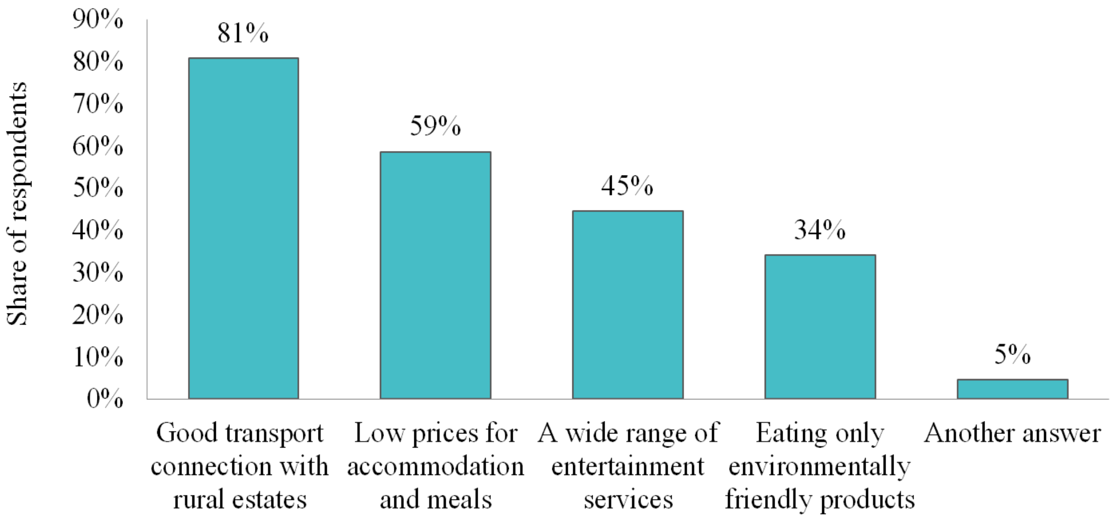

Fig. 9. Ways to stimulate demand for rural tourism in Ukraine
Source: own representation.

According to the conducted sociological survey, the rural area attracts tourists with a variety of unique features inherent peculiar to a certain area. It is worth noting that due to the COVID-19 pandemic, tourists more often began to choose the rest in small rural estates located in an ecologically clean area. It is here that a wide range of leisure services opens for tourists. They have the opportunity to choose interesting entertainment and educational routes as they wish, to take part in folklore events and song festivals, etc. Or tourists just can spend time in peace and quiet, which are so lacking in modern cities.

CONCLUSIONS

Based on our socio-economic research, which concerned the assessment of the level of awareness and attitude of the population of Ukraine to the development of rural tourism, we can draw the following conclusions:
-recreation in the rural area attracts the most of the surveyed citizens (92%);
-among the main advantages of recreation in rural area, respondents noted the picturesque landscapes and cozy atmosphere of the village (85%); hiking and horseback riding, picking berries and mushrooms, fishing (56%); acquaintance with local culture and life, national cuisine (55%);
-70% of respondents would like to rest in the region of the Ukrainian Carpathians;
-95% of respondents said that it is necessary to develop rural tourism in Ukraine;
54% of respondents want to start a business in this area;
-the majority of respondents (82%) believe that the Law of Ukraine "On Rural Tourism" should be adopted in order to clearly regulate activities in the field of rural tourism.
The development of rural tourism at the macro level opens new opportunities and prospects not only for the tourism industry, but also for the economy of Ukraine as a whole. This is an effective way to improve the economic, environmental, cultural and household situation in rural areas. The development of rural tourism helps to increase the income received by villagers, encourages the local population to protect nature, preserve national, cultural and historical heritage. That is why state support is very important, which would promote the development of rural tourism. It should include the attraction and effective use of foreign investment, the provision of soft long-term loans to rural residents for the organization and conduct of business, improving the activities of travel agencies for effective advertising of rural estates, and so on.
Our study makes it possible to identify the main factors that will contribute to the development of rural tourism in Ukraine. Important factors include the following: effective economic policy of the state in relation to rural tourism, available government funding and lending, reduction of the tax burden, creation of a favorable legal framework (including the adoption of the Law of Ukraine "On Rural Tourism"), development of village infrastructure, support of advertising and promotion of rural tourism services at the regional, state and international levels, improving the quality of these services. Ukrainian hospitality and rich cultural traditions attract tourists from near and far abroad.

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SUSTAINABLE DEVELOPMENT GOAL 2: ASSESSMENT OF NIGERIA'S FOOD SECURITY SITUATION FROM 1960 – 2020

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Abstract

This study analysed the food security situation in Nigeria between 1960 and 2020. The longitudinal survey design was used. Secondary data on food security indicators were obtained from World Development Indicators (WDI) of the World Bank, Food and Agriculture Organization (FAO), Central Bank of Nigeria (CBN), and National Bureau of Statistics (NBS). The data were analysed using descriptive statistics. Findings revealed a general upward trend in agricultural output, per capita food production, and per capita income. The country's agricultural output was relatively low during the independence f 1960 and the first decade. Further, there was instability in growth, this was followed by some slight increase prior to 2015 and 2016. The study also revealed low rate of per capita food production prior to late 1980. Before the oil boom, Nigeria's per capita income was relatively low; while the depth of food deficit obviously decreased from 75 kilocalories per person per day in 1997 to 42 kilocalories per person per day in 2016.This study concluded that Nigeria and Nigerians are having food insecurity problems – a very low value of food production per capita and a high depth of food deficit that has been on the increase since the past decade.

Key words: *agricultural output, depth of food deficit, SDG 2, food security, Nigeria*

INTRODUCTION

The definitions of food security abounds in the literature. Food security encompasses access (physical, social and economic) to food by people of all social status at all times in sufficient, safe, and nutritious state that meets their dietary needs and food preferences for an active, healthy, and productive life. This definition focus on the key dimensions of food security: food availability, food access, utilization and stability [6]. Carter and Barrett [4] defined food security as the ability of food-deficit nations to meet target levels of consumption on an annual basis. It also involves access by all people at all times to adequate food for active, healthy [19], and productive life. According to Idachaba [14], food security is the ability of individuals and households to meet the required or recommended food needs. It is also a state of affairs where all people at all times have access to quality, safe and nutritious food a healthy lifestyle [12].

The concept of food security originally dwelt on ensuring food availability and the price stability of basic foods items; this was occasioned by the extreme volatility of agricultural commodity prices and unstable nature of the currency and energy markets at that time [2]. Further, the occurrence of hunger and food shortages required a definition of food security which recognized the critical needs and behaviour of potentially vulnerable and affected people [21]. Indicatively, an understanding of the functioning of agricultural markets under stress conditions, and how at-risk populations found themselves unable to access food, led to the expansion of the FAO definition of food security to include securing access by vulnerable people to available supplies [2]. Furthermore, there was an extension of the concept of food security to include: "access of all people at all times to enough food for an active, healthy life" in 1986 when the World Bank published its seminal report on Poverty and Hunger; and eventually became a human right issue in 1994 following the UN Development Program's Human Development Report [2; 23].

The next development of the definition of food security was redefined further in the "The State of Food Insecurity in the World 2001" by adding the social emphasis [7]. It was reiterated that poverty reduction is a necessary, but not sufficient condition to achieving this goal [8]. Also, at the 2009 World Summit on Food Security, the fourth dimension of stability was added to the concept of food security [9]. In recent time however, scholar have suggested that sustainability be added as a fifth dimension to address the long-term aspect of food security [2].

Indicators of food security include numbers of: hungry or malnourished people, underweight children and people suffering from micronutrient deficiency [5]. Siamawalla and Valdes [22], conceptualized food security as the ability of the countries, regions or households to meet target levels of food consumption annually. Similarly, the Committee on World Food Security was of the view that food security focus on physical and economic access to adequate food for all household members, without any risk of losing such access. The World Bank [24] looked at food security as access by all people at all times to enough food for an active, healthy life. Food security is thus people-centred, with emphasis on physical and economic access to sufficient food at individual and/or household level without the risk of losing access.

Nwaniki, [18] earlier reported three dimensions to food security; availability, accessibility and adequacy Food availability has to do with the supply of food, that is to say, food should be sufficient in quantity and quality and also should be in variety. The right to sufficient food is enshrined in the universal declaration of human rights and in subsequent international law. Broadly, food security entails safety from basic physiological needs. The lack of safety will be manifested in chronic hunger or starvation and malnutrition. According to Eme *et al.* [5], it can either be chronic or transitory. Chronic food insecurity is a perpetual inadequate diet due to lack of resources to produce food. Transitory food insecurity, on the other hand, is a temporary decline in household's access to sufficient food due to instability in food production and prices, and/or reduction in household income. Both conditions are prevalent in sub-Saharan Africa and some parts of Asia [5].

Statistics have shown that over 7.1 million people in Nigeria are food insecure [6]. The larger percentage of this population depends on agriculture for their livelihoods. Expectedly, to meet the global demand for food which is to increase by 60 per cent in 2050, agricultural production must increase by 70–100 per cent [8]. For Nigeria to be self-sufficient in food production vis-à-vis food security, the agricultural sector must be consciously prioritized.

The concept of food security in a developing country like Nigeria could go simultaneously with poverty alleviation. Hence, it will suffice to say, hunger (food insecurity) and poverty are complementary. Particularly, the poverty phenomenon in Nigeria has attracted significant global attention in recent times. Evidence from literature and recent indices by relevant bodies/organizations identified Nigeria as one of the world's poorest countries and the country's economy largely depends on crude oil (65 per cent of total government revenues in 2018) [6], and agriculture as the primary source of income and food for her populace.

Sustainable Development Goal 2 (SDG 2) aims to achieve "zero hunger". It is one of the 17 Sustainable Development Goals established by the United Nations in 2015. The target of this goal is to end hunger, achieve food security, improve nutrition, and promote sustainable agriculture by the year 2030. In Nigeria, the Millennium Development Goal (MDG) of reduction of extreme hunger is an articulated pointer whose commitment by world leaders was to be actualized in 2015; this target still remains a mirage, even in 2021. Consequently, Nigeria's attainment of SDG 2 by 2030 seems unrealistic. There is therefore the need to assess the various elements or food security indicators in the country within the study period.

MATERIALS AND METHODS

This study was conducted on Nigeria. Nigeria is one of the sub-Saharan African nations located in West Africa with a population of over 200,000,000, using the country's population growth rate (National Population Commission, 2006). The spatial distribution of the population is uneven with the majority (63 per cent) living in rural areas and the remaining population living in the urban areas [National Bureau of Statistics, NBS, 16]. The country is located between 3^0 and 14^0 East Longitudes and 4^0 and 14^0 North Latitudes (NBS, 2020). Nigeria is bordered on the west by the Republics of Benin and Niger; on the east by the Republic of Cameroon; on the north by Niger and Chad Republics and the south by the Gulf of Guinea. The coast of Nigeria is a belt of mangrove swamps traversed by a network of creeks and rivers and the great Niger Delta. The climate is equatorial and semi-equatorial in nature, characterized by high humidity and substantial rainfall. There are two seasons – the wet and dry seasons. The wet season lasts from April to October, while the dry season lasts from November through March.
Time series data for the period 1960 – 2020 on agricultural output, per capita food production, per capita income, and depth of food deficit were sourced from publications of: World Development Indicators (WDI) of the World Bank, Food and Agriculture Organization (FAO), Central Bank of Nigeria (CBN), and National Bureau of Statistics (NBS). Graphs were used to present the findings.

RESULTS AND DISCUSSIONS

National food security exists when a country's residents have physical and economic access to sufficient, safe, and nutritious food for a healthy and productive life at all times. FAO, WFP and IFAD [10] identified food availability, per capita food production, percentage of under-five who are underweight, percentage of under-five who are stunted, domestic food price volatility, and depth of food deficit as some of the key indicators of food security. Availability and affordability of food are one of the key objectives of any serious economy as survival of human beings who in turn pilot the affairs of other sectors of the economy, depends on food availability. Following FAO's position and the need for food affordability, the following were adopted as food security indicators in this study:

Agricultural Output/Food Production

The trend of agricultural output in Nigeria from 1960 – 2020 is presented in Figure 1. The country's agricultural output generally experienced upward trend during the period under study. Specifically, the trend shows that, during the independence and first decade, the country's agricultural output was relatively low. The increase was somewhat impressive in the early 1980 to early 2000. After some staggered growth, the country's agricultural output experienced rapid slight increase prior to 2015 and continued to increase after 2016. The increase in agricultural output may have implications on food security in terms of food availability.

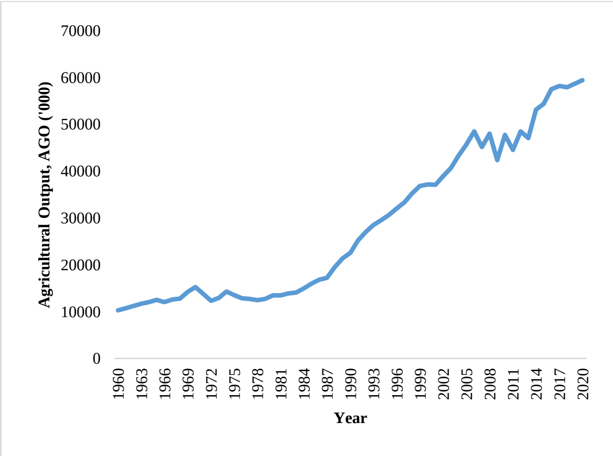

Fig. 1. Nigeria's Agricultural Output (AGO), 1960 – 2020
Source: Author's Computation using WDI Data, 2021 [26].

The observed output pattern in this study is similar to the report of Abah *et al.* [1] and Kalikume [15] who found that agricultural output in Nigeria has risen substantially over the years.

Per Capita Food Production (kcal/per capita/day)

The graph for the trend of per capita food production in Nigeria within the study period as presented in Figure 2 reveals that the country had maintained a consistent increase in the domestic supply of food over the years. The increase was however relatively slow prior to late 1980, after when the country experienced significant growth in per capita food production. Despite the unstable growth in 2009 and 2013, Nigeria's per capita food production further peaked in 2018 and has been on the increase. The observed pattern in this study is similar to Nkonya *et al*. [20]. FAO [9] and Holmen [13] also observed an increasing per capita food production in Nigeria.

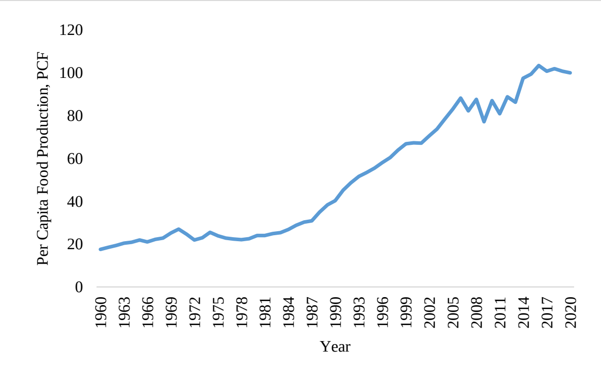

Fig. 2. Nigeria's Per Capita Food Production (PCF), 1960 – 2020
Source: Author's Computation using WDI Data, 2021 [26].

Per Capita Income

The trend of Nigeria's per capita income within the period under study is presented in Figure 3. Per capita income measures the average income earned per person in the country, and it is calculated by dividing the area's total income by its total population. Per capita income has implications on individual's ability to purchase food; 'proxying' the affordability aspect of food security. The graph shows unstable pattern in Nigeria's per capita income between 1960 and 2020. The per capita income was relatively low prior to the discovery of oil and peaked in 1982. This value however drastically dropped in the early 1990's, after which the country experienced some gradual upward trend in per capita income, except for around 2009 and 2017 which recorded sharp decline.

The noticeable increase at various times of the year in the country's per capita income could be associated with the recorded Gross National Income (GNI) and Gross Domestic Period (GDP) in those years.

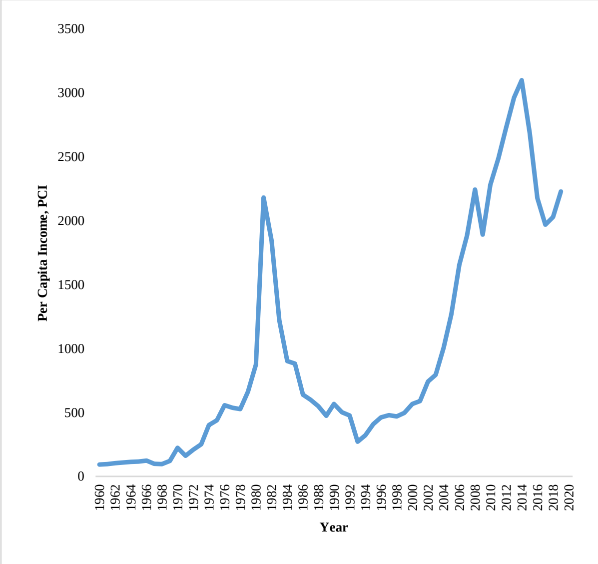

Fig. 3. Graph of Nigeria's Per Capita Income (PCI), 1960 – 2020
Source: Author's Computation using WDI Data, 2021 [26].

Depth of Food Deficit (DFD)

The trend of Nigeria's depth of food deficit is presented in Figure 4. The depth of food deficit is a measurement of how many calories would be needed to lift the undernourished from their status, *all else equal* [25]. According to FAO [11], DFD measure the average per capita amount of additional energy (kcals) needed for undernourished individuals to meet the Average Energy Requirement (ADER). This indicator is useful for problem identification, advocacy, and global and national monitoring [20].

Figure 4 shows that, prior to the availability of a national document on agricultural policy, the country's depth of food deficit was above 100 kcal/person/day. Depth of food deficit of Nigeria decreased from 75 kilocalories per person per day in 1997 to 42 kilocalories per person per day in 2016. This figure however increased and the tendency of continuous increase in the coming years is quite high. This is despite the observed food crop production increases which have not kept pace with population growth, resulting in rising food imports and declining levels of national food self-sufficiency. This is in line with Thomas Malthusian's theory. Nigeria is endowed with abundant land and human resources to produce enough food commodities not only for domestic consumption but also for export. If the potential of agriculture resources is harnessed and all institutional frameworks are in order, the depth of food deficit will continue to decrease.

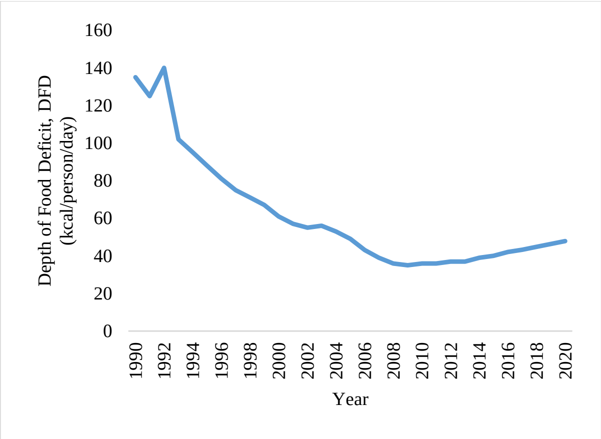

Fig. 4. Nigeria's Depth of Food Deficit
Source: Author's Computation using WDI Data, 2021 [26].

The observed pattern in Nigeria's DFD during the period under study could also be associated with seasonality, price spikes, or climate related shocks to the country's food system. This result corroborates the position of Cafiero and Pietro [3] who reported similar findings.

CONCLUSIONS

Following the Sustainable Development Goal 2, which aims at eliminating hunger and achieve sustainable food security globally by the year 2030, this study was motivated by the need to contribute to the frontiers of knowledge that will help understand Nigeria's food security situation. The statistics on food security indicators within the study period show that Nigeria and Nigerians are having food insecurity problems – a very low value of food production per capita and a high depth of food deficit that has been on the increase since the past decade.

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FAIR ALLOCATION OF COST ELEMENTS PER PRODUCT

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Abstract

Concerns related to production costs in general, their analysis and, implicitly, the methods used for this purpose derive from the need of economic agents to produce high quality products, while seeking to incur costs as low as possible. It can be said that this issue must be given the necessary attention because only through a continuous analysis of production costs companies may survive and develop in an increasingly unfavorable, unstable economic environment, marked by fierce competition in all areas of activity and a continuous increase in the prices of used resources. Cost analysis represents an important area in the efficient operation of the enterprise in terms of limited resources, its task being to provide the necessary information to managers in order to develop strategic decisions.

Key words**:** *production cost, production volume, cost analysis, direct and indirect costs, product unit*

INTRODUCTION

The analysis of this paper focuses on a stock company whose main object of activity is the production, marketing and industrialization of agro-zoo technical products.
The company exploits on average annually 4,000 ha of arable land of which 3,000 irrigated ha and also deals with the raising of dairy cattle whose herd varies around 1,450 head of cattle of which 800 head of herd.
The company produces on the arable land surface grains and technical plants as well as fodder necessary for the animal growing sector. In the animal production, the company deals with the production of cow's milk and the fattening of cattle.
The social capital of the company is 5,015 thousand lei.
The company is organized in production farms and specialized service sectors of production farms. Thus, the company has the following subunits:
- 3 farms with vegetal profile;
- 1 dairy cattle farm;
- the service sector with a profile for repairing agricultural equipment and the execution of agricultural specific services towards the company's farms;
- the supply, sales, transport sector which has as an objective the assurance of the necessary materials for the production process, the sale of the products obtained by the farms and the management of the transport means necessary for the above activities;
- the financial-accounting department.

The company has a number of 219 employees, of which 184 permanent employees, 26 TESA staff, 35 seasonal workers.
The analysis of the company's indicators is performed based on the "Profit and loss account" which allows establishing the final result of the activity by measuring the effect reflected in net turnover with the effort reflected in the costs related to the consumption of material and human resources. The "profit and loss account" groups over a given management period all the economic flows generating income (as sources of enrichment) and expenses (as sources of impoverishment) [7].
Material and other direct costs, direct wage costs associated with the manufacture of a product or overall production are provided by the data contained in the basic accounting documents: consumption vouchers for raw materials and consumables, time sheets/reports, payroll statements, customer orders [9].
Indirect costs related to a product or production cannot be related to any output

document [6]. However, the allocation of these expenses for the determination of production costs is essential for the policy of determining the selling price, estimating or allocating the budget. In conclusion, we need methods of reasonably allocating indirect costs with their participation in the manufacture of a product or the entire production.

In this context the paper aimed to study how cost items are fairly allocated in the product cost.

MATERIALS AND METHODS

The study case taken as example is based on the data provided for the period 2017-2019 by the analyzed stock company, for grains.

The analyzed indicators have been the following ones:

-Production volume expressed in number of products;

- Material and other direct costs/Production volume expressed in Lei/product

-Indirect expenses/ Production volume - lei/product

-Direct salary expenses/ Production volume - lei /product

-Total direct and indirect expenses/ Production volume - lei/ product

Administrative and distribution expenses/ Production volume - lei /product

-Full Cost/ Production volume - lei/product/

The data were analyzed in their dynamics establishing the increase or decline in 2019 compared to the level in 2017.

RESULTS AND DISCUSSIONS

Production volume increased becoming more than double in 2019 compared to 2017.

Analyzing material expenses and other direct expenses per product unit, we notice that the average value reached 311 lei per product as it appears in the Table 1.

In 2017 and 2018, the production volume experienced a sensitive increase surpassed by the increase in direct material costs which is also seen in the increase of their share in the volume of production in 2019, we find that although the volume of production increased by 65% compared to the previous period, the direct material costs increased in a proportion of less than 55%, due to the investments made (purchases of modern machines and equipment). This situation led to a decrease in direct material costs per product unit to the value of 311 lei/product.

Table 1. Dynamics of the analyzed indicators reflecting production and cost items and the relationship between them

Crt. No.	Indicators	2017	2018	2019	2019/2017 %	Average value
1	Production volume- number of products thousand t grains	22.376	28.370	46.818	209.23	32.521
2	Material and other direct costs/ Production volume - lei/product	293	330	312	106.14	312
3	Indirect expenses/ production volume - lei/product	68	94.5	121	177.94	101.5
4	Direct salary expenses/production volume - lei/product	54	75.5	68	125.93	67.4
5	Total direct and indirect expenses / Production volume - lei /product	415	500	500	120.48	482
6	Administrative and distribution expenses/ Production volume - lei /product	25	27	43	172.00	34
7	Full Cost/Production volume - lei /product	441	528	545	123.58	516

Source: Own calculation based on the data from the analyzed company.

Table 1 also shows the indirect costs per product unit. For example, in 2017 the indirect expenses were 1,523,684 thousand lei and the quantity of units produced was

22,376,221, in 2018 the indirect expenses were 2,682,761 thousand lei and the quantity of units produced was 28,369,763 and in 2019 of 5,697,218 thousand lei, respectively 46,817,940 products. These values led to obtaining a rate of 68 lei/product in 2017, 94.5 lei/product in 2018, 121 lei/product in 2019.

The average rate for the entire period was calculated as 101.5 lei/product. Indirect expenses registered an average value of 3,301,221 thousand lei higher by 116.6% and 23% compared to 2017 and 2018 and lower by 42.06% compared to 2019, while the average value of the units produced was only 45.33% respectively 14.63% higher compared to 2017 and 2018 and 30.53% lower than in 2019. This situation was the cause for an average rate of indirect costs at a higher production volume.

This is one of the basic approaches for analyzing the differences between rates for distinct periods [1].

The method has its advantages and disadvantages. Applying the rate per product is the easiest to use in allocating indirect expenses. However, its usefulness is limited to situations involving a single product or several related products characterized by a common denominator. If there is no common denominator, we must determine another relevant and reasonable weighting factor [2]. We need to adapt the weighting factors per unit for a given period to the nature of the respective industry.

The table also shows the rates of direct wage expenditures per product unit required for their analysis. The rate of direct salary expenses per product unit reached on average 67.4 lei/product for the analyzed period. The highest rate of 75.5 lei/product was obtained in 2017 and was 12% higher than the average value. The cause is mainly the relatively higher increase in direct labor costs compared to the increase in units produced.

Analyzing the direct wage expenditures per product for 2019 compared to 2018, we observe a decrease of 10% resulting from a relatively higher increase in the number of units produced compared to the increase in direct labor expenditures.

Analysis of indirect costs per product unit. The simplest and most direct method for allocating indirect costs is based on the quantities of products obtained [4]. To obtain the rate, we divide the indirect costs by the units of manufactured product. Calculations may involve actual physical products, estimated physical products, or data from normal activity. Moreover, rates can be calculated for the entire unit, department, or cost center.

If the rate of indirect expenses is based on actual expenses for the given period, this is obtained by dividing the indirect expenses with the actual production expressed in value or physically. Indirect costs can be broken down by product either before or after the total costs have been determined with certainty [5].

Actual application rate = actual indirect costs/ actual production

To calculate a planned rate, we divide the estimated indirect costs with the estimated production expressed in value or physically [10].

Planned rate = Estimated indirect costs/ Estimated production

When we use the actual indirect costs, we cannot complete the pricing procedure until the end of the management period and this delay disadvantages us because we cannot determine the final costs until after the completion of the production report [8].

When indirect costs are estimated in advance, we can determine the costs per product immediately and thus mitigate the fluctuation activity.

On the other hand, the use of estimates can lead to under- or oversized values of indirect costs, which must be adjusted periodically through accounting records.

CONCLUSIONS

Analyzing the production cost per product unit, we observe identical values at the level of 2018 and 2019 of 500 lei/product. Although we noticed that in 2019 the direct unit expenses decreased, the share of indirect unit expenses in the average production cost increased by 28.04% compared to the level registered in 2018.

The administrative and distribution expenses per product unit reached values between 25 lei/product in 2017 and 43 lei/product in 2019, compared to the average value of the analyzed period of 34%.

Determining the cost elements per product unit helps us to quickly establish the cost per product and to detect unusual deviations in its evolution [3].

The cost element rates per product unit helps us estimate costs, set product prices, measure cost performance based on historical experience, analyze cost elements in detail, prepare the budget, and track its realization.

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ANALYSIS OF INDIRECT EXPENSES RATES

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Abstract

The requirements of management work determine the functions, objectives and methods of the cost information system. In turn, these elements (functions, objectives, methods) generate the informational structure for presenting the respective elements. Indirect expenses contribute adjacent to the support of current activities. In general, these expenses are not easily identified when manufacturing a product, providing direct services or meeting the direct requirements of a project. Instead, indirect expenses are accrued in detailed accounting records, allocated and reported by each firm. The expenses are then cumulated in centralized documents at departments level (production, quality assurance, administrative, sales, research and development) according to the organizational requirements. Their analysis can help us assess indirect spendings and control excessive spending. The key factors in monitoring these expenses are continuous surveillance, control measures and performance measurement.

Key words: *indirect expenses, cost, analysis, expenses rate*

INTRODUCTION

The analysis of this paper focuses on a stock company whose main object of activity is the production, marketing and industrialization of agro-zoo technical products. The company exploits on average annually 4,000 ha of arable land of which 3,000 irrigated ha and also deals with the raising of dairy cattle whose herd varies around 1,450 head of cattle of which 800 head of herd. The company produces on the arable land surface cereals and technical plants as well as fodder necessary for the animal growing sector. In the zootechnical production, the company deals with the production of cow's milk and the fattening of cattle. The social capital of the company is 5,015 thousand lei. The company is organized in production farms and specialized service sectors of production farms. Thus, the company has the following subunits:
- 3 farms with vegetal profile;
- 1 dairy cattle farm;
- the service sector with a profile for repairing agricultural equipment and the execution of agricultural specific services towards the company's farms;
- the supply, sales, transport sector which has as an objective the assurance of the necessary materials for the production process, the sale of the products obtained by the farms and the management of the transport means necessary for the above activities;
- the financial-accounting department.

The company has a number of 219 employees, of which 184 permanent employees, 26 TESA staff, 35 seasonal workers. For the analysis of indirect expenses, it is considered that the most used methods are the following:
-the rate of indirect expenses to direct salary expenses;
-direct hourly rate;
-the rate of indirect expenses to direct expenses (direct salary expenses + material expenses + other direct expenses);
-the percentage of indirect expenses in the net turnover and in the production cost [7]:
-the hourly cost method of operating the machine;
-the rate of indirect expenses at production value

MATERIALS AND METHODS

These statistics are used to evaluate actual performance and to plan indirect expenses.

However, these expenses are generally considered uncontrollable because their allocation is governed by social protection policy and procedures and the results of negotiations with the union which may build a major consideration [4].

In this study, there were determined the following rates:

-Indirect expenses/ Direct working hours - lei/hour

-Direct salary expenses /Direct working hours - lei/Hour

-Indirect expenses/Direct expenses -%

-Indirect expenses/Direct salary expenses -% - Indirect salary expenses/Direct salary expenses -%

The data are provided by the analyzed company.

RESULTS AND DISCUSSIONS

The average rate of indirect expenses to direct wage expenses for the analyzed period is 150.44%. The rate indicates that each leu spent on direct labor generates on average indirect expenses of 1.50 lei (Table 1).

Also, we find that in 2018 there was a sensitive increase compared to 2017, while in 2019 the share reached the value of 177.02%, respectively an increase compared to 2017 by 41.8%, compared to 2018 by 41.4% and exceeded the average value by 17.6%.

Indirect expenses rate statistics can be useful when estimating the costs of products per direct labor hour and we can also use it as a planning guide for creating overall factory (total) indirect expenses budgets [1].

working hours.

In order to determine this rate we divide the indirect expenses with the direct working hours. Before applying indirect costs, we need to determine the relationship between the amount of indirect costs to be applied and the number of direct working hours involved. The rate can be determined either by cost center, department, product, service or the entire activity [2].

Table 1. Calculation of the rates of cost elements

Indicators	2017	2018	2019	2019/2017 %	Average value
Direct working hours group of harvesting machines	46.800	59.392	89.856	192.00	65.349
Indirect expenses/ Direct working hours - lei/hour	32.557	45.170	63.404	194.74	50.517
Direct salary expenses /Direct working hours - lei /Hour	26.081	36.101	35.817	137.32	33.579
Direct expenses - thousand lei -	7.781	11.522	17.787	228.59	12.363
Indirect expenses / Direct expenses -%	19.58	23.28	32.03	163.58	26,70
Indirect expenses / Direct salary expenses -% -	124.83	125.12	177.02	141.80	150,44
Indirect salary expenses/Direct salary expenses -%	9.95	7.48	11.83	118.89	10.06

Source: Own calculation based on the data from the analyzed company.

Indirect expenses rate to the number of direct

In the table the average value of the rate is 50,517 lei/hour. The lowest value of the rate was 32,557 lei/hour in 2001, 45,170 lei/hour in 2018 (an increase of 38.7%) and 63,404 lei/hour in 2019, which is 25% above the average value. The increase in rates over the three years was due to both the increase in the number of employees, as well as the tariff wages.

The advantages of using this rate are: ease of use; it is a basis for realistic application when labor is the main factor in production.

The disadvantage of this procedure is similar to that of direct salary expenses: it ignores the contribution of other factors to the realization of the product [5].

For example, for the mechanical workshop of the company that includes a series of machines (drills, hammer drills, lathes, threading machines) it is unrealistic to apply indirect costs only to the number of hours worked without considering also other expenses.

Indirect expenses rate calculated on direct expenses. The firm can use such a rate if it proves useful for measuring planning and economic performance.

The table shows the average rate for the three years whose value is 26.7%. In 2017 the rate reached the value of 19.58, registering in 2018 a slight increase to 23.28%, but reaching in 2019 the value of 32.03, exceeding the average by 5.33% due to the renewal of labor means (the company purchased new machinery and equipment). In order to use such a rate effectively, we must perform a detailed analysis of the specific causes that led to changes in the categories of expenses, as well as the unusual circumstances that caused the fluctuations.

The advantages of this method are: it is easy to use; all necessary data are easily accessible from the accounting reports [9].

Disadvantages include:

-does not make use of the time factor in the allocation of indirect expenses;

-there is no logical relationship between most indirect costs and the value of raw materials;

-an accurate determination of indirect costs is unlikely to result from the use of direct labor due to potential errors that may occur in the design of material costs over time;

-the use of this rate is restricted in situations where there are no extreme variations in the realization of products;

-this method may prove to be more useful only in certain departments than at the level of the whole company.

Hourly cost method of operating the machine. In order to calculate the rate of indirect expenses during the hours of operation of the machine, we must first determine the relationship between the sum of indirect expenses to be allocated and the number of hours of operation of the machine. Indirect expenses are then allocated to the task or process by multiplying the operating hours of the machine involved in a particular activity at that rate. To obtain the hourly running cost of the machine, we divide the indirect costs for a specific machine (or for a group of machines if they are identical in activity and cost) by the relevant operating hours of the machine:

Hourly operating cost of the machine = Indirect expenses/Operating hours of the machine

In general, the hourly cost of operating the machine is an estimate of the amount of indirect costs per hour for the activity performed by each machine. Calculating the hourly operating cost of the machine involves the following steps:

1.The departments involved design the estimated indirect expenses for the period under review in the form of a budget plan.

2.We regroup the expense items into three categories: (a) expenses specific to each machine in terms of current, maintenance and depreciation; (b) heat, light and costs of the building; and (c) all other general and service costs, including various categories of activities.

3.We determine the total indirect expenses projected for the operation of each machine during the year. The car rate is the result of dividing this total by the number of operating hours.

When machines represent the most important factor in production, the hourly operating method of the machine undoubtedly has multiple advantages in allocating indirect expenses:

cost accounting provides the most accurate means of applying indirect expenses to each task or activity [3].

If the application of the hourly cost of operating the machine uses time as the basis for the allocation of indirect expenses, the rate is realistic even when an operator has to operate several machines or when several operators are required to operate a single machine.

The hourly operating costs of the machine allow the final fixation of the estimated sales prices for each task.

It is a realistic procedure for estimating the cost per product, with a high degree of accuracy.

The method of determining the indirect expenses involved in this rate is both logical and scientific.

Management can therefore rely on high-accuracy cost reports and be confident of the price offer to the customer. With such insurance, management can avoid either operating losses or failure in obtaining contracts. Moreover, the method provides a solid basis for measuring the monthly cost of unused machines.

The main disadvantages of the hourly cost method of operating the machine include:

the procedure increases costs because additional reports, which would not normally be required, must be produced and kept for the time required for each operation [8].

increases the number of operations in detailed cost accounting because a general rate cannot be used for each individual machine or group of machines [6].

As only a few companies can use only machine operating rates, also other types of rates must be used.

CONCLUSIONS

Analysing the indirect expenses, we determined their average rate at the production cost of 21.07% for the period of the three years: in 2017 – 16.38%, in 2018 – 18.89% and in 2019 – 24.26%.

Analyzing the indirect expenses of the financial year 2019, we notice an increase in depreciation expenses due to the acquisition of tangible assets according to the policy of modernization and refurbishment of production.

The information obtained from the cost analysis is being used in the elaboration of the company's strategy.

The cost domination strategy is the most widespread of all microeconomic strategies [10]. The purpose of this strategy is to determine a cost as low as possible and implicitly finding those ways to achieve cost savings.

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STUDY ON THE DYNAMICS OF POTATO PRODUCTION AND WORLDWIDE TRADING DURING THE PERIOD 2012-2019

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Abstract

The paper presents a series of aspects regarding the evolution of potato production and trade worldwide, for the period 2012-2019. In the present study were analyzed a series of benchmarks for the world sector of potatoes production and trading. The main indicators that have been presented and analyzed are: areas cultivated with potatoes worldwide; total potato production; average production per hectare of potatoes; consumption of potatoes; potatoes world trade. The world potato production sector has undergone substantial changes, but it remains one of the important sectors of activity, as the potato occupies a key place on the scale of important foods for the world's population food. According to statistics, China is the leader in the ranking of potato production. Data taken from the FAO website were used in the paper.

Key words**:** *potato, potato production, average production per hectare of potatoes, import, export.*

INTRODUCTION

The potato originated in the Andes of South America, and in the eighteenth century the potato crop for food became important for the rural population and for those on low incomes from Europe and North America [13].
Globally, the potato is grown for its tubers, because they are widely used to obtain various preparations [2, 11].
Sweet potato tubers have been used to feed people since ancient times [10, 12]. Currently, we find the potato culture all over the globe, from the Equator to the polar regions. This culture is possible up to latitudes of 70-72^0 and altitudes of 1,000-1,500 m.
It is necessary to specify an important aspect, namely that the potato, in addition to providing food to the population, is a valuable raw material for various industries.
The potato has a special nutritional value, as follows: carbohydrates 12.0-33.9%; protein 1.88%; lipids 0.14%; mineral salts-Ca, K, Na, Fe, P, vitamin C (20-25 mg/100g sp); vitamin B_1 (0.1 mg/100g s.p.); vitamin B_6 (0.2-0.3 mg/100g s.p.); pantothenic acid (0.3-0.63 mg /100g s.p.); folic acid (0.1 mg/100g s.p.) [2].
Currently, worldwide, the potato is on the fourth position in the top of food production after: wheat; corn and rice [13].

Photo 1. Potato culture
Source: [9].

Worldwide, the leaders in the ranking in terms of potato production are: China; India and Russia. They are interested in producing potatoes because it is a more profitable crop compared to other crops [12].
Worldwide, according to published data, only 2/3 of the potato production obtained is consumed by the world's population, and the rest is used in various sectors of activity [1, 8, 12].
As for the consumption of potatoes worldwide, it has undergone a number of

changes. Currently, there are two consumption trends, namely:
-in less developed countries the consumption of potatoes is on an increasing trend;
-in the developed countries the consumption of potatoes is on an decreasing trend [3, 7, 12].
Potato culture has a number of advantages for farmers, namely:
-has no pretensions to the weather conditions;
-does not require large investments;
-substantial average yields per hectare can be obtained;
-it is also suitable for small surfaces, etc [12].

Photo 2. Flowering potato crop
Source: [5].

MATERIALS AND METHODS

The paper presents the evolution of potato production and trade worldwide, for the period 2012-2019. In order to point out as well as possible the dynamics manifested on the world potato market, the analysis of the following indicators was imposed: the surfaces cultivated with potatoes worldwide; worldwide potato production; average production per hectare of potatoes worldwide; worldwide consumption of potatoes; and also quantitative and value imports and exports for the category „Potatoes". For the accomplishment of the present work, statistical data taken from the FAOSTAT site were used. The research results are presented in the paperwork in graphic form.

RESULTS AND DISCUSSIONS

FAO data on the area cultivated with potatoes worldwide show that it varied from one year to another during the analyzed period (Fig.1).

The most significant area cultivated with potatoes was registered in 2012 (18,698,323 ha), and the smallest area was cultivated in 2018 (17,164,096 ha). In 2019, the area cultivated with potatoes worldwide decreased by 7.26%, compared to 2012.

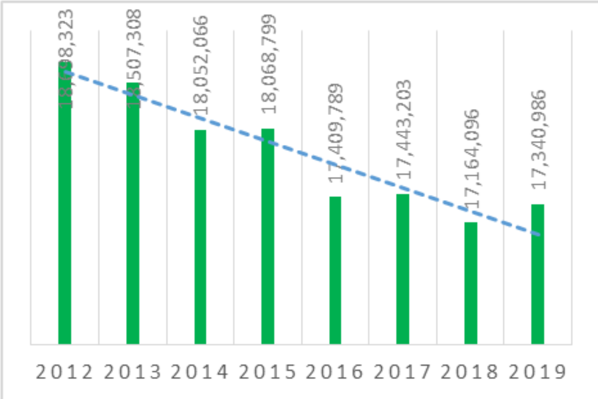

Fig. 1. Area cultivated with potatoes worldwide, for the period 2012-2019 (hectares)
Source: Own design based on FAOSTAT database 2021 [4].

According to the statistical data presented and analyzed regarding the potato production achieved worldwide during the period under analysis, it was observed that it changed from one year to another (Fig. 2).

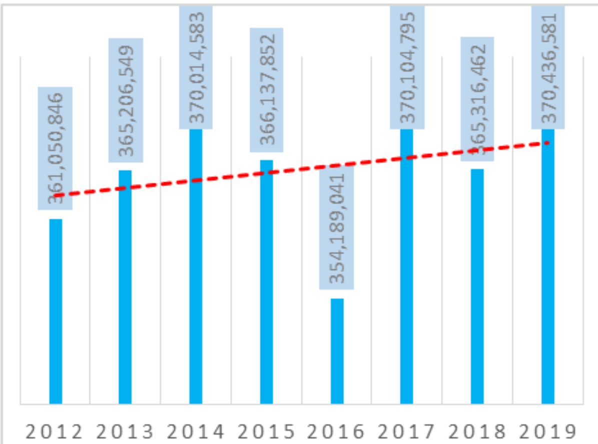

Fig. 2. Worldwide potato production, for the period 2012-2019 (tons)
Source: Own design based on FAOSTAT database 2021 [4].

The most representative potato production achieved worldwide was 370,436,581 tons (2019), and the lowest production was 354,189,041 tons (2016). In 2019, world potato production increased by only 2.59%, compared to 2012.

At the continental level we find a differentiated potato production determined by a series of significant factors. In 2012, Asia achieved the largest potato production of 170,295,511 tons (47.2% of the total world production). In the top of the potato producing continents, on the 2nd place is Europe with a production of 116,656,731 tons (32.3% of the total world production). At the opposite pole, it can be easily seen that Oceania is positioned with a production of 1,854,674 tons, which represents only 0.5% of the world potato production.

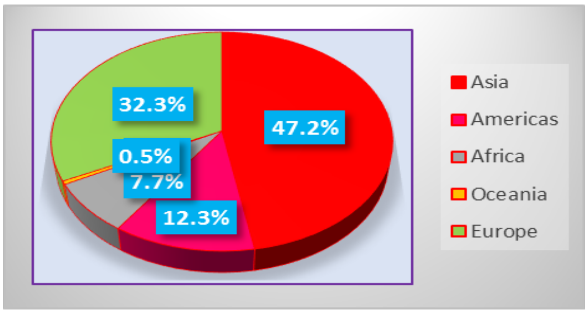

Fig. 3. The share of potato production by regions in 2012 (%)
Source: Own design based on FAOSTAT database 2021 [4].

In 2019, at regional level, the leader in the ranking of production also remained Asia, but with a higher production compared to the potato production registered in 2012. In 2019, the potato production achieved in Asia was 189,810,377 tons (51.1% of the world potato production), 11.4% higher than in 2012. In this ranking, Europe ranks 2nd, with a potato production of 107,264,935 tons (29% of the world potato production). In 2019, potato production in Europe decreased by 8.1%, compared to 2012. On the third place is America with a production of 45,083,546 tons (12.2% of the world potato production). In 2019, for America there is a 1.4% increase in potato production, compared to 2012. The fourth place in this ranking is held by Africa with a potato production of 26,534,489 tons (7.2% of the world potato production). The lowest production was recorded by Oceania, namely 1,743,234 tons (0.5% of the world potato production), which places it in the 5th place. In 2019, potato production in Oceania decreased by 6.1%, compared to 2012.

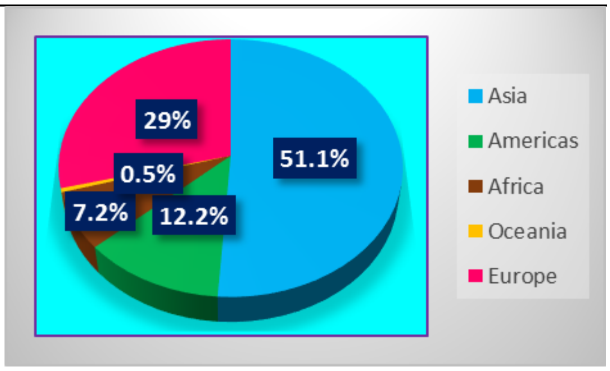

Fig. 4. The share of potato production by regions in 2019 (%)
Source: Own design based on FAOSTAT database 2021 [4].

In 2019, the three world leaders in potato production were: China (91,818,950 tons, respectively 24.78% of the world potato production); India (50,190,000 tons, respectively 13.54% of the world potato production) and Russia (22,436,581 tons, respectively 5.95% of the world potato production). The three major potato-producing countries in 2019 together accounted for more than 44% of the world potato production [12].

World potato production was directly influenced by the cultivated area and the average production achieved per hectare. According to data provided by FAO, the average potato production obtained worldwide in the period 2012-2019 has varied (Fig. 5). The highest average production per hectare of potatoes was achieved in 2019 (21,361.9 kg/ha), and the lowest average production was 19,309.3 kg/ha.

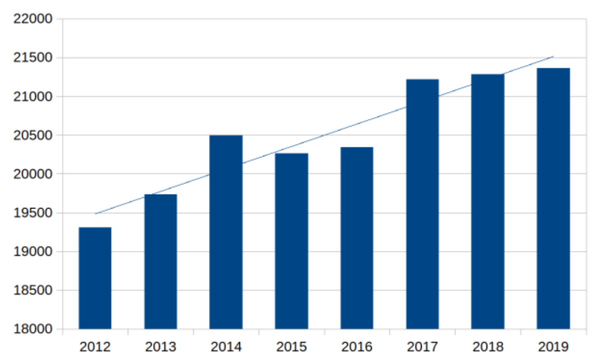

Fig. 5. Average production per hectare of potatoes worldwide, for the period 2012-2019 (kg/ha)
Source: Own design based on FAOSTAT database 2021 [4].

Worldwide, the average consumption of potatoes per capita according to statistical data published by Faostat for 2018, was of 32.93 kg. Per capita consumption decreased in 2018, compared to 2014, by 3.97%. Regarding the average consumption of potatoes per capita from a historical point of view, it reached a maximum in 1961 (35.7 kg), but also a historical minimum in 1991 (26.0 kg) [6].

In 2018, according to Faostat data published in 2019, Belarus (182 kg) ranked first in the world in terms of per capita potato consumption. At the opposite pole, Cambodia had the lowest consumption (0.062 kg).

Quantitative imports of potatoes worldwide varied between 2012-2015, and starting with 2016 they were on an upward trend (Fig. 6).

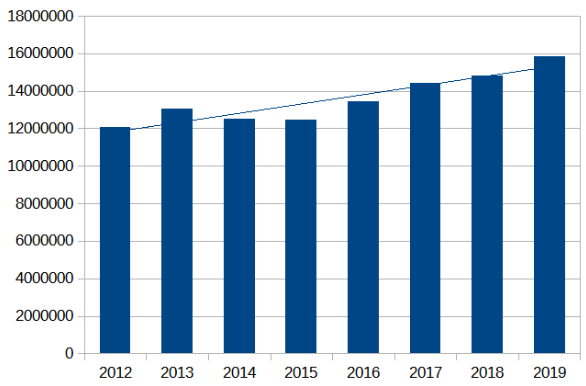

Fig. 6. Quantitative imports of potatoes worldwide, for the period 2012-2019 (tons)

Source: Own design based on FAOSTAT database 2021 [4].

The smallest quantitative imports of potatoes worldwide were registered in 2012 (12,083,168 tons), and the most significant were made in 2019 (15,821,372 tons). Quantitative imports of potatoes worldwide in 2019, increased by 30.39% compared to 2012.

At regional level, in 2019, the quantitative imports of potatoes were: Europe (10,803,179 tons); Asia (3,091,559 tons); Americas (1,088,552 tons); Africa (810,254 tons) and Oceania (27,828 tons).

From the data presented it can be seen that Europe is the leader in terms of quantitative imports of potatoes. In 2019, Europe accounted for 68.28% of potato imports worldwide. The lowest quantitative imports of potatoes were recorded by Oceania, accounting for only 0.17% of the imports recorded worldwide in 2019.

The top 5 potato importers for 2019 consisted of: Belgium (3,141,332 tons); the Netherlands (1,907,297 tons); Spain (838,183 tons); Germany (749,772 tons) and Italy (640,284 tons) [4].

Belgium in 2019 accounted for 19.85% of the quantitative imports of potatoes registered worldwide and 29.07% of the quantitative imports achieved in Europe.

The value imports for the "Potatoes" category registered worldwide have changed from one year to another (Fig. 7). The most significant value imports were registered in 2019 (5,360,452 thousand $). They increased by 39.54% in 2019, compared to 2012. The smallest value imports were registered in 2015 (3,823,958 thousand $). At continental level in 2019, the value imports for the "Potatoes" category were presented as follows: Europe (3,498,059 thousand $); Asia (966,208 thousand $); Americas (503,153 thousand $); Africa (376,170 thousand $) and Oceania (16,862 thousand $).

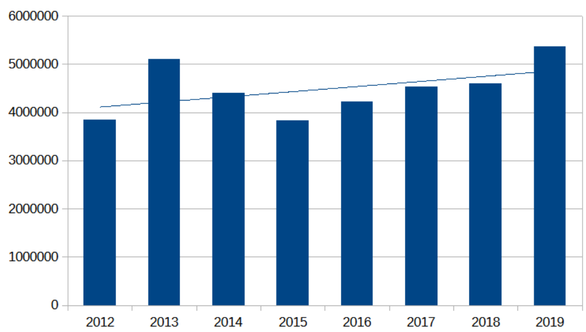

Fig. 7. Value imports for the category "Potatoes" achieved worldwide between 2012-2019 (thousand $)

Source: Own design based on FAOSTAT database 2021 [4].

Worldwide, quantitative potato exports fluctuated during the analyzed period (Fig. 8). The most substantial quantitative exports for the "Potatoes" category were registered in 2019 (14,748,559 tons), and the lowest quantitative exports were 11,104,513 tons (2012). In 2019, the quantitative exports for the "Potatoes" category increased by 32.81%, compared to 2012.

Quantitative exports for the "Potatoes" category at regional level for 2019 were:

Europe (9,506,642 tons); Asia (3,018,729 tons); Americas (1,135,981 tons); Africa (1,010,363 tons); Oceania (76,844 tons).

Europe in 2019 accounted for 64.45% of the potato exports worldwide.

It is necessary to specify for 2019 the top 5 exporters of potatoes registered worldwide included the following countries: France (2,323,364 tons); the Netherlands (2,282,985 tons); Germany (1,875,696 tons); Belgium (998,672 tons); Egypt (684,735 tons);

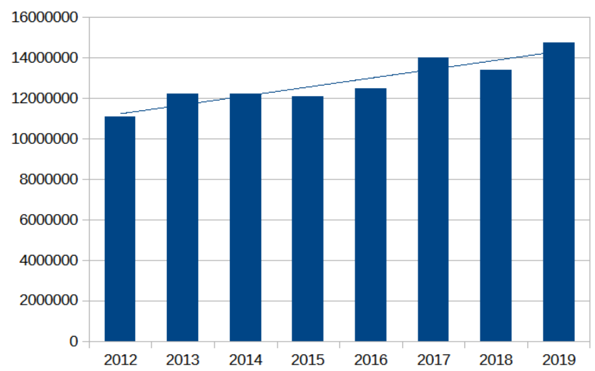

Fig. 8. Quantitative exports of potatoes worldwide, between 2012-2019 (tons)
Source: Own design based on FAOSTAT database 2021 [4].

Value exports for the "Potatoes" category achieved worldwide varied in the period under analysis (see Fig.9). The highest value exports were highlighted in 2019 (5,147,224 thousand $).

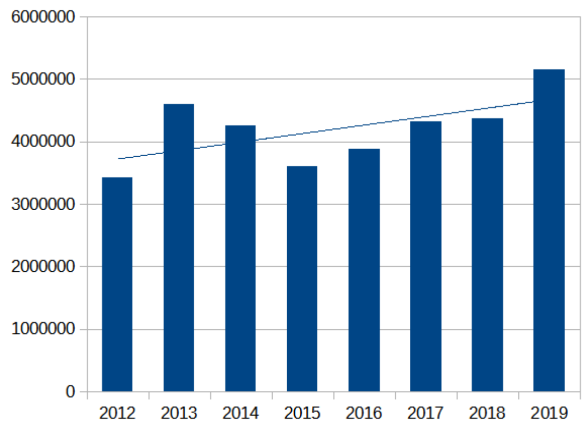

Fig. 9. Value exports for the category "Potatoes" between 2012-2019 (thousand dollars)
Source: Own design based on FAOSTAT database 2021 [4].

The value of exports increased in 2019 by 50.24%, compared to 2012. The lowest value of exports was achieved in 2012 (3,425,990 thousand $).

CONCLUSIONS

The analysis of the main indicators related to the potato production and marketing sector worldwide, in the period 2012-2019, highlighted the following aspects:

-the largest area cultivated with potatoes was of 18,698,323 ha (2012);

-in 2019, the world's largest potato production of 370,436,581 tons was achieved;

-at the regional level in 2012, Asia obtained the most significant potato production of 170,295,511 tons;

-in 2018, the average world consumption of potatoes per capita was of 32.93 kg;

-in 2019, the largest quantitative imports of potatoes of 15,821,372 tons were achieved;

-the highest value of imports was 5,360,452 thousand $ (2019);

-the highest quantitative exports were of 14,748,559 tons (2019);

-Europe, achieved over 60.0% of the quantitative exports of potatoes registered worldwide for 2019;

-the value of exports increased by 50.24% in 2019, compared to 2012.

Currently, the global potato production and marketing sector is in full development because, on the one hand, the potato is one of the most important food for the planet's population, and on the other hand, we are witnessing an increase in the demand for potatoes for industrial processing.

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RESEARCH ON SUGAR BEET PRODUCTION AND TRADE - WORLDWIDE OVERVIEW

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Abstract

The research highlights aspects of the production and commercialization of sugar beet at the worldwide level. The analysis is considering 2012-2019 based on specific indicators relating production and commercialization of sugar beet. The statistical data used in this research were taken from the FAO. The most representative indicators analyzed in the study refers to the areas cultivated with sugar beet worldwide, total sugar beet production, average production per hectare of sugar beet and imports and exports of sugar beet. According to the data, Europe is the largest producer of sugar beet in the world. In this context, Europe obtained over 60% of the sugar beet production registered worldwide with different uses. Globally, sugar made from sugar beet has only 20% of sugar production. The difference in production obtained worldwide is made from sugar cane.

Key words*: *sugar beet, average production, sale, export, import

INTRODUCTION

The present research is based on the statistical analysis of the production and marketing of sugar beet, an approach that has been achieved worldwide. The interest in sugar beet is given by the fact that it is a crop with great territorial spread, used in the processing activities of the food industry. Sugar beet also generates significant income for producers and is part of the national agri - food chain. In addition, sugar beet contributes of trade between countries, through import and export. Besides the economic particularities generating high profitability, sugar beet has certain biological and technological characteristics that determine a good correlation with other crops, being a very good precursor in crop rotation. Sugar beets are one of those crops that capitalize well on organic and mineral fertilization [10].
It should be noted that the chemical composition of sugar beet is influenced by several factors such as technology, various pedoclimatic conditions [12].

Sugar beet (*Beta vulgaris var. Saccharifera*) is a biennial crop from the Mediterranean Sea, cultivated mainly for sugar [3, 14].
From sugar beet obtains Molasses as a processing result used in the food industry, but also in the alcohol industry .The sugar beet is a biennial. In the first year of vegetation forms the body, and in the second year it forms the fruiting flowering branches [4, 13].
Sugar beet consumes many nutrients from the soil. To obtain a ton of roots and leaves of sugar beet are necessary 4.0-5.0 kg of nitrogen; 5.5-6.0 kg of potassium; 1.5-2.0 kg phosphorus; 2.5 kg of calcium and 1.5 kg of manganese. This crop requires organic fertilization for the entire area cultivated with manure, well fermented, in a dose of 40-50 tons per hectare. This dose is necessary, especially to obtain sugar beet products larger than 50 tons per hectare [1].
Europe is the highest producer of sugar beet in the world, achieving over 60% of total production worldwide. Statistics show that the European Union is the world's largest producer of beet sugar, covering about half of

world production. The most important areas cultivated with sugar beet found in the northern half of Europe, because of the climate favors. Significant sugar beet production is obtained in Germany, Belgium, Lower Countries, Northern France, and Poland. The great exporters of sugar beet are also countries in the European Union as Germany, Belgium, Hungary, Slovakia, Letonia [5].

The sugar beet is a great crop for production of bioethanol used in car industry. Due of this, increased demand for sugar beet in Europe, as important producer [2, 11].

Using the most appropriate technology, sugar beet increases substantial income to farmers.

Photo 1. Sugar beet culture
Source: [8].

Photo 2. Sugar beet
Source: [8].

MATERIALS AND METHODS

The study is an economic analysis of sugar beet producing and its commercialization starting from relevance as a particular crop in agri-food field. The research on producing and sugar beet commercialization consider specific indicators which provide a realistic overview about the total cultivated area at the worldwide level, total production, and the commercial balance means import and sugar beet export, quantitative and value, too. In the period 2012-2019, the results obtained from FAOSTAT are debate as plain text and graphical one to explain the value correlation between indicators results.

To carry out this research, a series of specialized materials were studied, and the research results were presented using economic influences factors.

RESULTS AND DISCUSSIONS

The FAOSTAT data on the total area cultivated with sugar beet worldwide, registered changes during the analyzed period. (Figure 1). The largest cultivated area with sugar beet worldwide was in 2017 (4,989,641 ha), and the smallest cultivated area was in 2015 (4,215,084 ha). In 2019, the area cultivated with sugar beet worldwide decreased by 4.67%, compared to 2012.

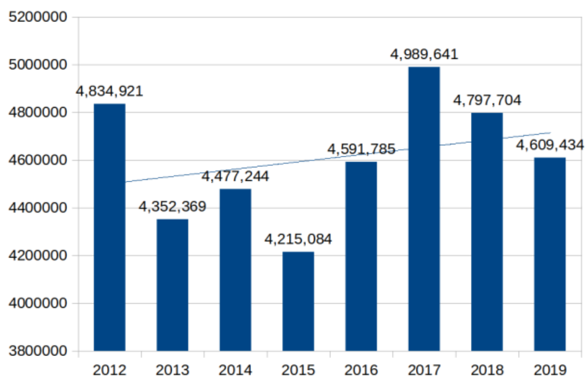

Fig. 1. Sugar beet worldwide area, period 2012-2019 (hectares)
Source: Own design based on FAOSTAT database 2021 [6].

World sugar beet production changed in 2012-2019 (Figure 2). It found out that the production of sugar beet in the analyzed period was influenced on the one hand by the cultivated area and on the other hand by the average production per hectare achieved.

The data presented shows that the most significant production of sugar beet worldwide was achieved in 2017 (313,989,402 tons).

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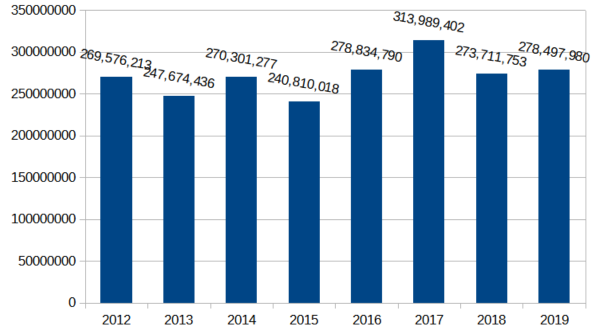

Fig. 2. Worldwide sugar beet production, period 2012-2019 (tons)
Source: Own design based on FAOSTAT database 2021 [6].

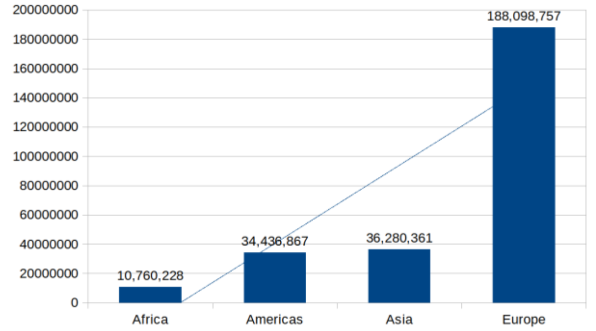

Fig. 3. Worldwide sugar beet production, 2012 (tons)
Source: Own design based on FAOSTAT database 2021 [6].

Also in 2017, the largest area with sugar beet was cultivated worldwide, which shows a strong correlation between area and production. In 2015, the world's lowest sugar beet production was 240,810,018 tons as an influence of cultivated area [7].

In 2017, the production of sugar beet achieved at the world level increased by 30.38%, compared to 2015, when a minimum was registered to produce sugar beet obtained worldwide. In 2019, the production of sugar beet increased by 3.30%, compared to 2012, but decreased by 11.31%, compared to 2017.

At continental level, from the data analyzed it is found that are differences from one region to another one (Figure 3). The difference in sugar beet production was due to several factors such as: cultivated area, farmers' interest, production technology, average production per hectare, level of profitability. From instance, Europe is the first producer of sugar beet compared with America, Asia, or Africa. It is a real gap between the regions of these continents, as seen in the graph. The explanation consists in the influencing factors that act at the level of each region, the main being cultivated area, technology used, average production, profitability. Beyond these economic factors, the level of sugar beet production on continents is influenced by macroeconomic factors specific to each region, more relevant being agricultural policy to support this crop, demand, the level of development of farmers, sell price, expenditures, especially variables ones, tradition.

Globally, there are gaps of the sugar beet area. For instance, in Oceania is a lack of the sugar beet area due to inadequate climatic conditions. Europe achieved the largest production of sugar beet on the continental level, of 188,098,757 tons (69.7% of world production in 2012 year), being the leader of the ranking. On the following positions, but at a great distance, the realized productions are the following: Asia (36,280,361 tons, respectively 13.5% of the realized world production); America (34,436,867 tons, respectively 12.8% of the world sugar beet production) and Africa (10,760,228 tons, respectively 4% of the world sugar beet production (Figure 4).

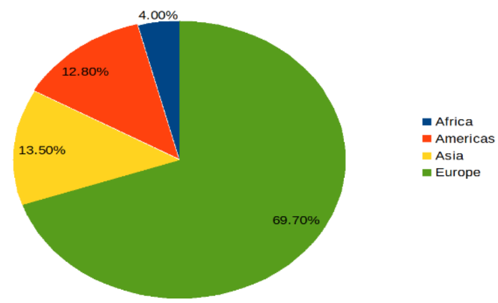

Fig. 4. Continental sugar beet production, 2012 (%)
Source: Own design based on FAOSTAT database 2021 [6].

At the continental level, production of sugar beet changed in the period 2012-2019. Europe maintained its first position in the top of sugar beet production (194,460,403 tons, Figure 5). In Europe, production increased in 2019 by 3.38% compared to 2012. A second place is occupied by Asia, with a sugar beet production of 41,507, 477 tons (2019). In Asia, in 2019, compared to 2012, the production of sugar beet increased 14.40%.

America ranks third in this ranking with a production of 28,225,847 tons (2019). In America, sugar beet production decreased by 18.6% in 2019 compared to 2012 and Africa achieved the lowest sugar beet production in the region, by 14,304,253 tons.

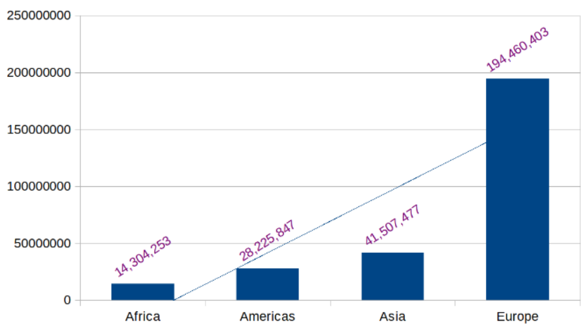

Fig. 5. Continental sugar beet production, 2019 (tons)
Source: Own design based on FAOSTAT database 2021 [6].

Referring Africa, the analysis done in the mentioned period increased by 32.93%. This increase in production is due primarily to the increase in cultivated area from 207,229 ha (2012) to 266,863 ha (2019). The area cultivated with sugar beet increased by 28.77%, in 2019 compared to 2012. There is a direct correlation between the area cultivated with sugar beet and the production obtained.
According to the data provided by FAOSTAT for 2019, Europe accounted for 69.8% of world production (Figure 6). This share changed insignificantly in 2019.

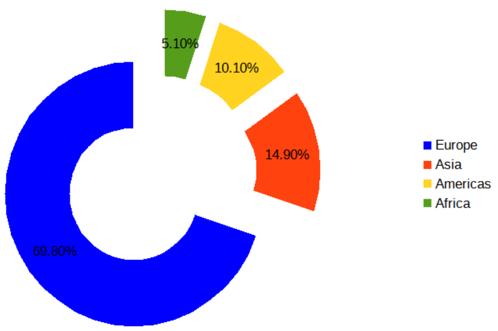

Fig. 6. Continental sugar beet production, 2019 (%)
Source: Own design based on FAOSTAT database 2021 [6].

On continents, the level of sugar beet production in the world production is shared between Asia (14.9%), America (10.1%) and Africa (5.1%).

The production of sugar beet, which was achieved worldwide in 2012-2019, was determined by several factors. Among them mention the average production, total cultivated area, degree of fertilization, ecological factors.
The average production of sugar beet achieved worldwide, in the period 2012-2019, varies (Figure 7).
The highest level of average sugar beet production achieved worldwide was 62.9 tons/ha (2017), and the lowest was 55.7 tons/ha (2012). In 2019, the average production per hectare of sugar beet increased by 8.43%, compared to 2012. Also, in 2019, the average production per hectare of sugar beet decreased by 3.98%, compared to 2017, when a maximum was recorded for the average production in the analyzed range.

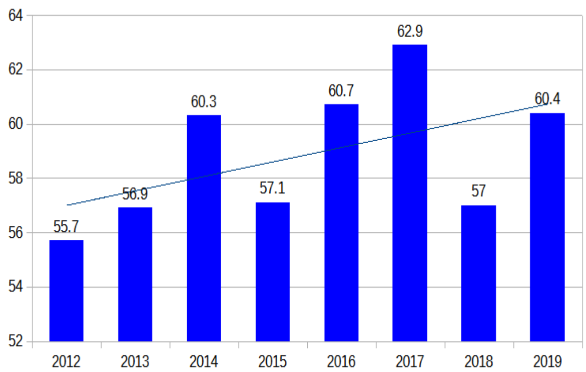

Fig. 7. Worldwide sugar beet average production, period 2012-2019 (Tons/ha)
Source: Own design based on FAOSTAT database 2021 [6].

The quantitative imports varied in 2012-2019.
In 2014, the most significant imports of sugar beet of 1,047,279 tons were registered worldwide. The lowest imports were 523,383 tons (2017). In 2019. In 2019, the quantitative imports of sugar beet decreased by 33.42%, compared to 2012.
According to the FAOSTAT data for 2012, the quantitative imports of sugar beet at continental level registered differences. There refers to Europe (662,822 tons), America (246,963 tons), Asia (35,523 tons), Africa (1,886 tons) and Oceania (4.0 tons).

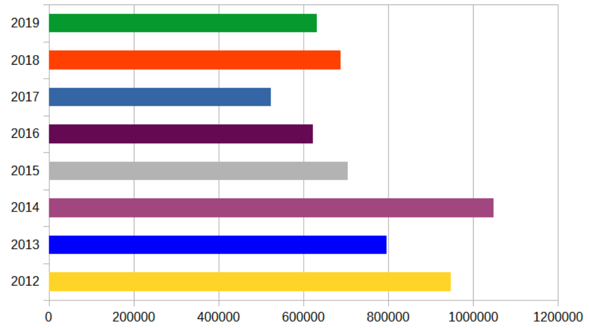

Fig. 8. Worldwide sugar beet imports and export period 2012-2019 (tons)
Source: Own design based on FAOSTAT database 2021 [6].

From the presented data observes there are large gaps at the continental level regarding the quantitative imports of sugar beet (Figure 9).

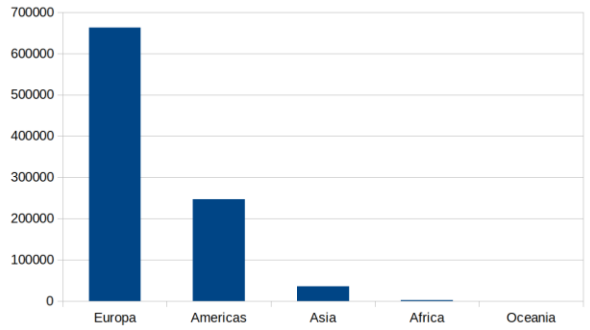

Fig. 9. Region's sugar beet quantitative imports period 2012 (tons)
Source: Own design based on FAOSTAT database 2021 [6].

In accordance with the FAOSTAT data, in 2019 the most significant importers of sugar beet were: Switzerland with 212,334 tons which means 33.6% of total imports of sugar beet, Czech Republic with 151,022 tons (23.9%), Croatia with 141,965 tons (22.5%), Germany with 37,299 tons (5.9%) and Lithuania with 22,139 tons (3.5%) (Figure 10).
Regard the quantitative imports of sugar beet at regional level the data shows differences between Europe (625,574 tons), America (2,013 tons), Asia (1,793 tons), Oceania (1,335 tons) and Africa (9.0 tons).
The analysis of the data on quantitative imports at regional level reveals a substantial decrease in 2019, compared to 2012, in Europe (-37.248 tons), America (244,950 tons), Asia (33,730 tons) and Africa (-1,877 tons).

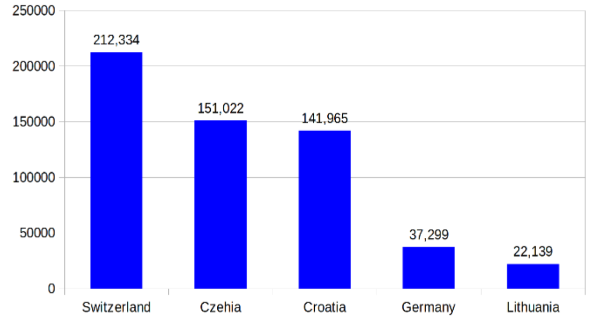

Fig. 10. Worldwide importers of sugar beet, 2019 (tons)
Source: Own design based on FAOSTAT database 2021 [6].

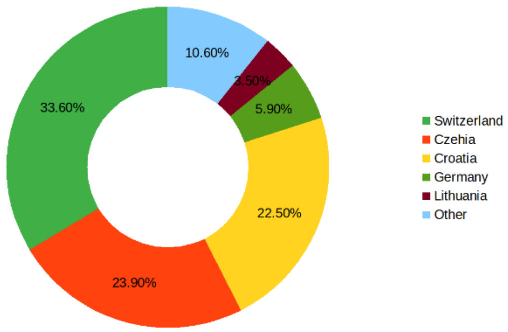

Fig. 11. Worldwide importers of sugar beet, 2019 (%)
Source: Own design based on FAOSTAT database 2021 [6].

During the period under analysis, there was only one exception to the evolution of quantitative imports of sugar beet, namely Oceania (+1,331 tons).
World sugar beet exports varied from year to year during the analysed period (Figure 11).

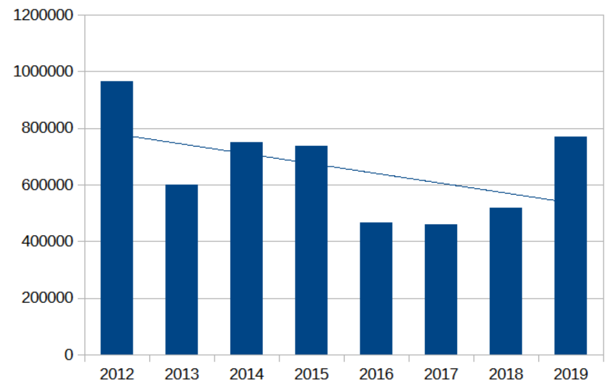

Fig. 12. Worldwide sugar beet exports, period 2012-2019 (tons)
Source: Own design based on FAOSTAT database 2021 [6].

Worldwide, the highest level of sugar beet represented 966,003 tons, in 2012, but the smallest were in 2017 (458,892 tons).

Also, the worldwide quantitative exports of sugar beet decreased in 2019 by 20.18%, compared to 2012.

At regional level, in 2012, the quantitative exports of sugar beet were as follows: Europe (678,647 tons, 70.25% of world sugar beet exports), Americas (248,599 tons, 25.73% of world sugar beet exports), (Asia 38,583 tons, 3.99% of world sugar beet exports), Africa (163 tons, 0.01% of world sugar beet exports) and Oceania (11.0 tons).

In 2019, Europe remained the leader in the ranking of world sugar beet exports (767,077 tons, 99.47% of world sugar beet exports). However, in 2019, the quantitative exports done by Europe decreased by 194,862 tons, compared to 2012. According to FAOSTAT, other regions registered exports such as Asia (2,122 tons), Africa (1,858 tons), America (84, 0 tons).

The ranking of the first sugar beet exporters highlighted worldwide for 2019 were: Germany (285,653 tons); Belgium (136,761 tons); Hungary (125,442 tons); Slovakia (96,360 tons) and Letonia (48,304 tons).

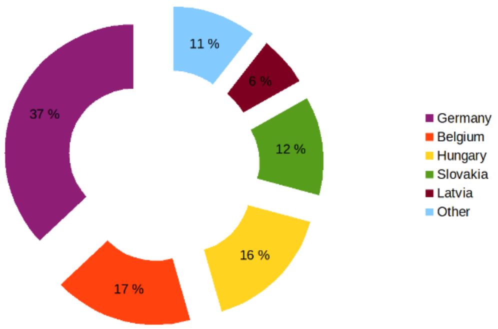

Fig. 13. Quantitative exports of sugar beet on main exporters, 2019 (%)
Source: Own design based on FAOSTAT database 2021 [6].

The data analysed shows that Europe is the largest exporter of sugar beet, because of cultivated area and production, too. At the same time, the European Union countries are the main importers.

CONCLUSIONS

The research showed relevant aspects of sugar beet crop from the economic point of view, at the worldwide level. The analysis of the indicators of sugar beet worldwide for the interval subject to analysis referred cultivated area, total production and average, exports and imports. The results highlighted the differences between regions and countries, some of them representative as results from data. An overview on the data showed that at the worldwide the largest area cultivated with sugar beet was registered in 2017, of 4,989,641 ha, also, the highest sugar beet production was 313,989,402 tons.

Referring production, in 2019, Europe achieved a sugar beet production of 194,460,403 tons. In 2017, there was a more representative average production per hectare of sugar beet of 62.9 tons / ha. Considering commercial exchanges, the largest quantitative imports of sugar beet were highlighted in 2014 (1,047,279 tons). In 2019, the most representative importer of sugar beet was Switzerland with 212,334 tons. In 2012, the largest exports of sugar beet were registered, of 966,003 tons.

Europe is the great in terms of quantitative exports of sugar beet, and in 2019, exported 767,077 tons.

The higher exporter of sugar beet in Europe is Germany with 285,653 tons (2019).

Sugar beet is one of the crops with several uses particularly food industry.

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ASPECTS REGARDING THE IMPACT OF LOCAL ACTION GROUPS (LAG) FINANCING THROUGH LEADER, ON RURAL DEVELOPMENT OF THE ELIGIBLE TERRITORY IN ROMANIA

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Abstract

This article analyzes the local action groups in terms of the impact of funding obtained through measure 19 LEADER of the National Rural Development Program. Has it benefits or not? How relevant are the indicators achieved and their contribution to the economic and social development of the LAG territory. Also, the progress made by the local action group in the period between the approval of LDS by MARD and 31.01.2021, the degree of fulfillment of the assumed obligations as well as direct or indirect connections between financing are subject to analysis received through measure 19 LEADER, the indicators achieved and the degree of rural development of the area. Regarding the evaluation of the local action groups, the additional bonus stage, the one that analyzes their activity in the period between the LDS approval, respectively the year 2016 and 31.01.2021 (with reference to the programming period 2014-2020) finances the structures with over 21 million euro, financial allocations from other NDRP sources. In view of this additional funding, over 60% of public-private partnerships attracted additional funds, resulting in over 3,400 jobs, which is a positive premise for the rural development of the LAG.

Key words*: *LAG, LEADER, development, rural, strategy, evaluation

INTRODUCTION

The 239 local action groups in Romania are authorized following the approval of the Local Development Strategy (LDS) by the Managing Authority. Each LDS is unique and specific to each LAG, starting from the individuality of the territory and the uniqueness of the LEADER approach, namely the seven basic principles: territorial approach, bottom-up approach, local partnerships, innovation, integrated approach, cooperation, funding and local management. Obviously, each LDS must meet certain eligibility and scoring criteria in order to be evaluated and subsequently approved.

It must contain objectives structured according to the National Rural Development Plan, but especially, in order to be eligible, it must be elaborated based on a bottom-up approach, starting from the basic needs of the targeted territory [12]. In the period 2014-2020, the 239 local action groups received an allocation in public value of 563,515,550.96 euros. Most local action groups are found in the North-East and South regions, with the highest financial allocations. On average, the highest value of the allocation is in the West region, 3,096,948,392 euros above the national average of 2,357,809,837 euros and the lowest in the Bucharest-Ilfov region, 1,155,099.61 euros, below the national average. In the Local Development Strategy based on which it operates, each Local Action Group assumes certain performance indicators arising from the implementation of projects that are subject to funding received through measure 19 LEADER [1]. The indicators do not show the same amount at the level of each local Action Group [8]. Depending on the particularities of each local action group, monitoring indicators can be found such as: the number of jobs created as a result of LDS implementation, the number of supported agricultural holdings, the number of supported non-agricultural businesses, etc. [13], [9].

MATERIALS AND METHODS

The information presented will highlight the economic - financial aspects of the local action groups at national and regional level resulting from obtaining the financing through M19 LEADER.

The financial allocation obtained within sub-measure 19.2 (the budget of the Local Development Strategy), the absorbed financial allocation, as well as their percentage quantification will be highlighted.

For a simpler example, certain analyzes will be made using the averages of the values, both at national and regional level, due to the large volume of data. The data resulted from the administrative analysis of the documents as well as from their own processing, using mathematical modeling: Pearson's correlation coefficient and polynomial function. Regarding mathematical modeling, the most commonly used is the person's correlation coefficient r (linear correlation coefficient), which measures the degree of correlation between variables.

$$r_{xy} = \frac{\sum_i (x_i - \bar{x}) \cdot (y_i - \bar{y})}{\sqrt{\sum_i (x_i - \bar{x})^2 \cdot \sum_i (y_i - \bar{y})^2}}$$

where: X and Y- are the averages for the samples. The correlation coefficient r has values between -1 and 1. The + or - sign shows the type (direction of the relationship), and the numerical value shows the intensity of the relationship, as follows: 1 - perfect inverse, negative correlation; 0 - zero or no correlation; 1 - perfect direct-positive correlation. In this case, the existence of correlations between various variables will be verified, directly or indirectly resulting from the financing of the Local Action Groups through measure 19 LEADER.

In the analysis, the values of the correlation coefficient (r) and the determination coefficient will be presented (R2).

RESULTS AND DISCUSSIONS

The activity of the Local Action Group is subject to periodic evaluation in order to establish its level of performance and possibly to be bonused or penalized [3]. Its evaluation is made according to the data reported by each local action group to the Managing Authority based on the indicators previously established and assumed. It should be mentioned that the main role of evaluating the implementation of the LDS of a local action group is to reveal the progress made and not to propose a penalty [4]**.** At the same time, the purpose of the evaluation is to study to what extent the proposed actions were well substantiated in the ex-ante stage of LDS elaboration, starting from the SWOT analysis of the eligible territory of the Local Action Group. Thus, some well-identified actions will lead to the minimization or resolution of the deficiencies initially identified, this being reflected mainly in the living standard of the citizens from the LAG territory. In the opposite sense, proposed actions without a correct identification of the insufficiencies of the territory will not lead to encouraging results, will not attenuate the existing disparities, thus minimizing the impact of financial allocation due to measure 19 LEADER. The migration of the rural population to the urban centers or other developed countries is an assiduous problem of the Romanian village[2]. In the 2014-2020 period, with reference to the local action groups, two rounds of bonuses / penalties were proposed, based on the normative acts MARD Order No. 553 Since 27.11.2019 [5] which provides the reference period the moment between the LDS approval and 30.09.2019 and MARD Order No. 57 Since 11.03.2021 [6], which provides for the bonus based on the evaluation of the activity of the Local Action Group the period between the LDS approval until 31.01.2021. The relevant aspects of the two stages are presented in Table 1. It is observed that the two stages have similarities, but also substantial differences. If the first stage contains "mandatory" thresholds to be reached, applying penalties where they did not fall within the specified limits, the second stage of the bonus has an optional character, but implicitly derives from the achievement of the necessary indicators of fulfilled in the first stage, the evaluated type horizon being longer. Also, if the first stage of the bonus involved the distribution of the amounts collected due to non-compliance with the minimum indicators, the LDSs value at national level remaining the same, the second stage came with additional allocations, the LDSs value being supplemented by 21,308,254.58 euros the amount of 584,824,805.51 euros [7].

Table 1. Relevant aspects of the evaluation of local action groups activity, in the two bonus stages.

Bonus according to OMARD 553/27.11.2019 - reference period 2016*-30.09.2019 - includes penalties [4]	**Additional bonus according to OMARD 57-11.03.2021 - reference period 2016*- 31.01.2021 [5]**
Indicators: - reaching a level of at least 60% contracted value relative to the total value of LDSs (including operating expenses)	Indicators: at least 80% contracted value (19.2) - at least 50% value paid (authorized payments / total value LDSs- 19.2 - jobs created> = 80%
Bonus value = 2,522,162.40 euros	Bonus value = 21,308,364 euros
Bonus funds come from the amount of penalties collected	The funds come from the amounts available at sM 19.2 and 19.4 -NDRP 2014-2020
Number of bonused LAGs = 18	Number of bonused LAGs = 146
The distribution of amounts is done according to an algorithm	The distribution of the amounts is made equally to the 146 LAGs (145,947 euros)
LAGs penalized in S-V Oltenia = 1 = 101,416.61 euros Bonused LAGs in S-V Oltenia = 4 = 583,202.66 euros	Bonused LAGs in S-V Oltenia = 16 = 2,335,152 euros Dolj = 5; Gorj = 2; Mehedinti = 4; Olt = 2; VL = 3
The value of LDSs = 563,516,550.93 euros	The value of LDSs = 584,824,805.51 euros

Source: own processing after www.madr.ro (accessed 30.06.2021)
*The moment of LDS approval

The analysis of the contracted funds reveals the following situation: the average value of the funds contracted at national level from LDS (19.2) is 1,884,891.76 euros. Above the average of the contracted national value are found the North-East, South, West, South-West Oltenia and North-West regions, at the top of the ranking being the West region, with an average of 2,501,067.33 euros (Figure 1). On the other hand, below the national contracted average value are the South-East, North-West, Center and Bucharest-Ilfov regions, which also have the lowest contracted value at 19.2 and 802,573.90 euros, respectively (Figure 1). As a percentage, the average contracted value compared to the average value of LDS (19.2), at regional level, places the North East region on the first place (92.66%), followed by the Center queen (90.86%). The South-West Oltenia region contracted funds in a percentage of 88.74%, the ranking being concluded by the Bucharest-Ilfov region, with a contracting degree of 60.73% (Figure 3). The situation of the paid funds compared to the contracted funds (average values) places the South-West Oltenia region at the forefront, with an average of the paid value of 1,245,335.29 euros, above the national average of 1,064,600.63 euros. On the marginal place is the Bucharest-Ilfov region, with an average of the paid value of 204,238.59 euros, well below the average national value, as shown in Figure 2. As a percentage, the average value paid compared to the average value of LDS (19.2) places the North-East region in first place (62.50%), followed by the South-West Oltenia region (61.74%), the ranking being concluded by the Bucharest-Ilfov region (23.54%). The situation changes if we talk about the ratio of the average value paid to the average value contracted from LDS (19.2). In this case, the South-West Oltenia region is the leader in paid contracts (71.63%), which means a high degree of implementation, followed by the South region (70.21%). The Bucharest-Ilfov region paid 41.90% of the value of the contracted funds, as shown in Figure 3.

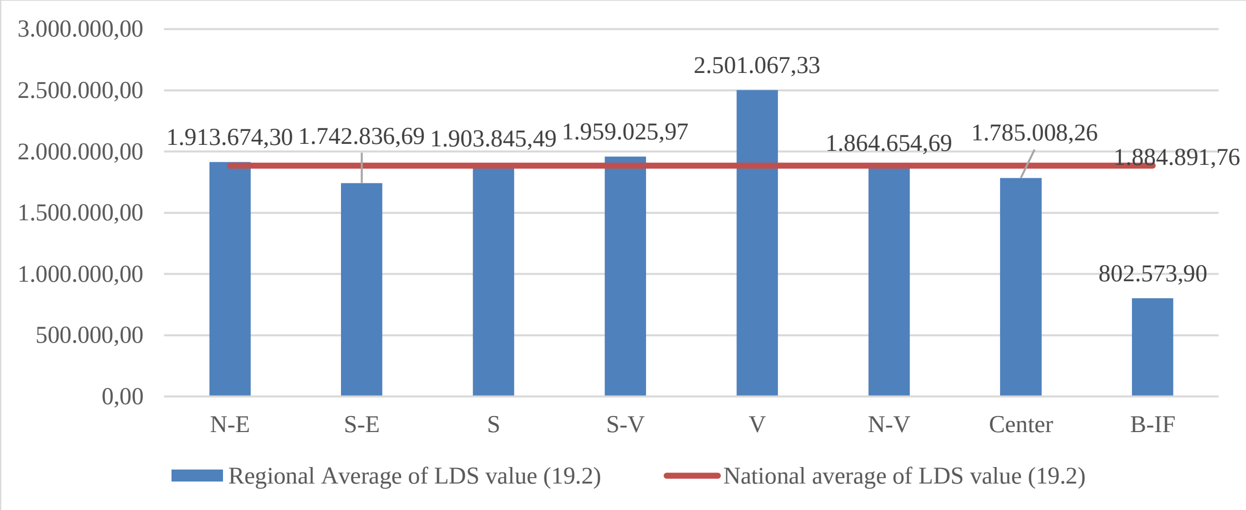

Fig. 1. Average LDS-19.2 value distributed at national and regional level (euro)
Source: own processing according to data collected www.madr.ro (30.06.2021)

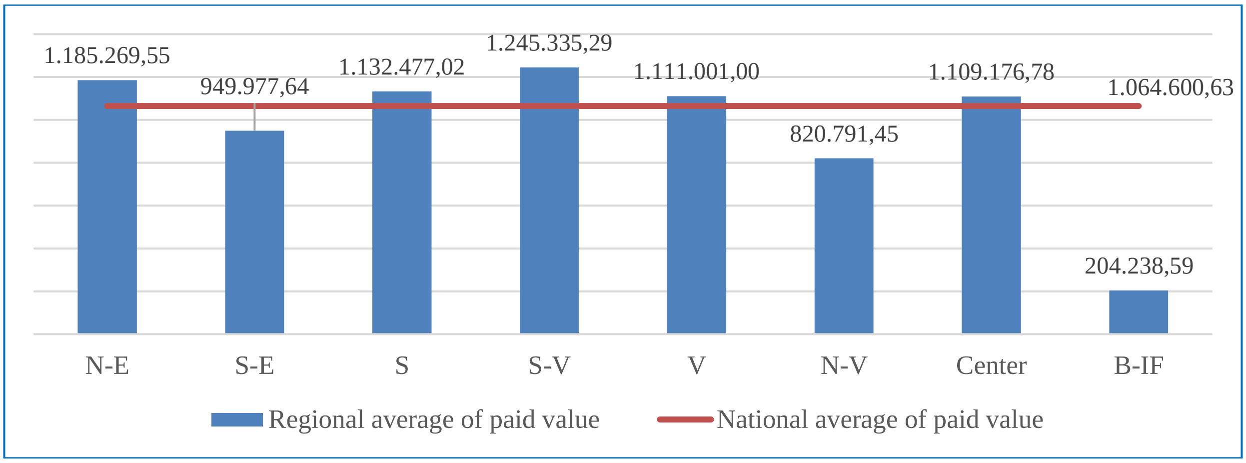

Fig. 2. Average paid value distributed at national and regional level (euro)
Source: own processing according to data collected www.madr.ro (30.06.2021)

One of the indicators assumed in the Local Development Strategies of all LAGs is the number of jobs created. By assuming and approving the Local Development Strategy by the Management Authority, the Local Action Group has to create a certain number of jobs, which derives from the implementation of the IN actions within the proposed financing measures [11]. The number of jobs created at the level of the reference period (31.01.2021) is significantly higher than the number of jobs assumed in the stage of elaboration of the local development strategy, in total being exceeded by 234 [10]. Most regions have exceeded the number of jobs assumed, only three of them being below the proposed level, as shown in Table 2. Obviously, the specificity of the measures proposed for funding contributes to the sizing of this indicator, some requiring more human resources, others not. Analyzing Table 2, we can conclude that the funding absorbed through measure 19 LEADER, within the NRDP has a positive impact on the region

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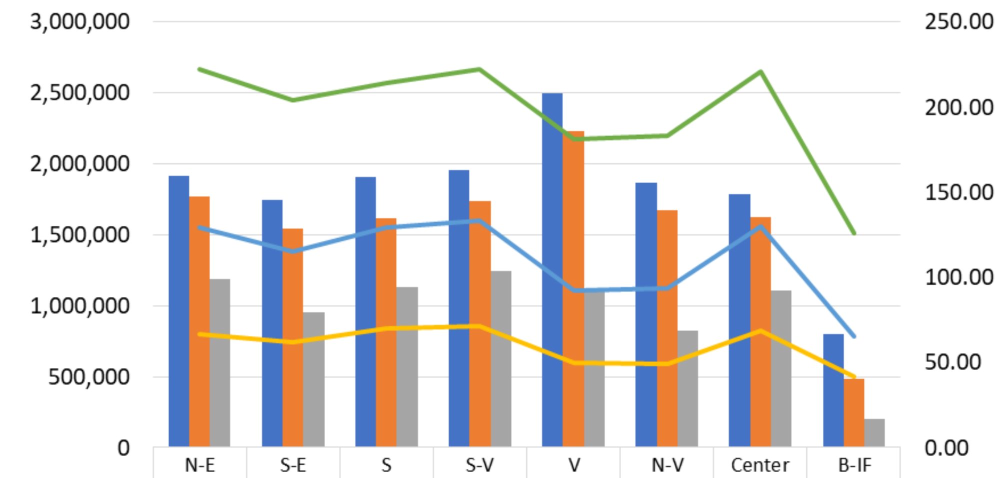
from an economic and social point of view, in this case the two structures being interconnected. In order to deepen the impact that this indicator has at the level of each region, we will analyze its influence on the degree of relative poverty, respectively if there is any correlation between the two variables. It should be mentioned, however, that the degree of relative poverty is an indicator whose analysis requires a long enough time horizon to observe its evolution. Thus, in the data presented in Table 3, we observe that the highest degree of relative poverty is in the NW region (41.1%) and 549 jobs were created and the lowest is in the B-Ilfov region (2.9%), where 57 jobs were created. The S-Muntenia region, through the proposed measures, contributed to the creation of 638 jobs, this having a poverty rate of 26%. The tabular representation in Table 4 as well as the graphical representation in Figure 4, demonstrate the fact that between the two variables there is a direct positive moderate correlation, respectively there is a certain influence of the poverty rate on the number of jobs created.



	N-E	S-E	S	S-V	V	N-V	Center	B-IF
LDS Value*	1,913,674	1,742,837	1,903,845	1,959,026	2,501,067	1,864,655	1,785,008	802,574
Contracted Value*	1,773,298	1,541,458	1,613,071	1,738,503	2,228,871	1,669,013	1,621,937	487,434
Paid Value*	1,185,270	949,978	1,132,477	1,245,335	1,111,001	820,791	1,109,177	204,239
Contracted Value/LDS Value- %	92.66	88.45	84.73	88.74	89.12	89.51	90.86	60.73
Paid Value/LDS Value* -%	62.50	53.80	59.06	61.74	42.42	44.58	61.31	23.54
Paid Value/Contracted Value* -%	66.84	61.63	70.21	71.63	49.85	49.18	68.39	41.90

Fig. 3. Situation of the main financial indicators of the LAGs on 31.01.2021
Source: own processing according to data collected www.madr.ro (30.06.2021)

Table 2. The situation of the number of jobs assumed, respectively created on 31.01.2021

Region	No of jobs proposed in LDS	No of jobs created
N-E	479	549
S-E	460	381
S-Muntenia	546	638
S-V Oltenia	390	329
V	400	459
N-V	438	534
Center	470	532
B-Ilfov	62	57
Total	**3,245**	**3,479**

Source: Own processing according to data www.madr.ro.

Table 3. Number of jobs created and relative poverty rate

Region	Relative poverty rate* = %	No. of jobs created
N-E	41.1	549
S-E	31.1	381
S-Muntenia	26	638
S-V Oltenia	31.6	329
V	14.7	459
N-V	14.7	534
Center	21.2	532
B-Ilfov	2.9	57

Source: Own processing according to data www.madr.ro and *Tempo Online.

Table 4. Table representation of the values of the correlation between the number of jobs created and the relative poverty rate

Correlation	r	R2	R2	R2	R2
No. of jobs created/ Relative poverty rate	Coef. Pearson	Linear function	Polynomial function - 2nd degree	Polynomial function - 3rd degree	Polynomial function - 4th degree
	0.5029*	0.253	0.534	0.813	0.9127

Source: Own processing.

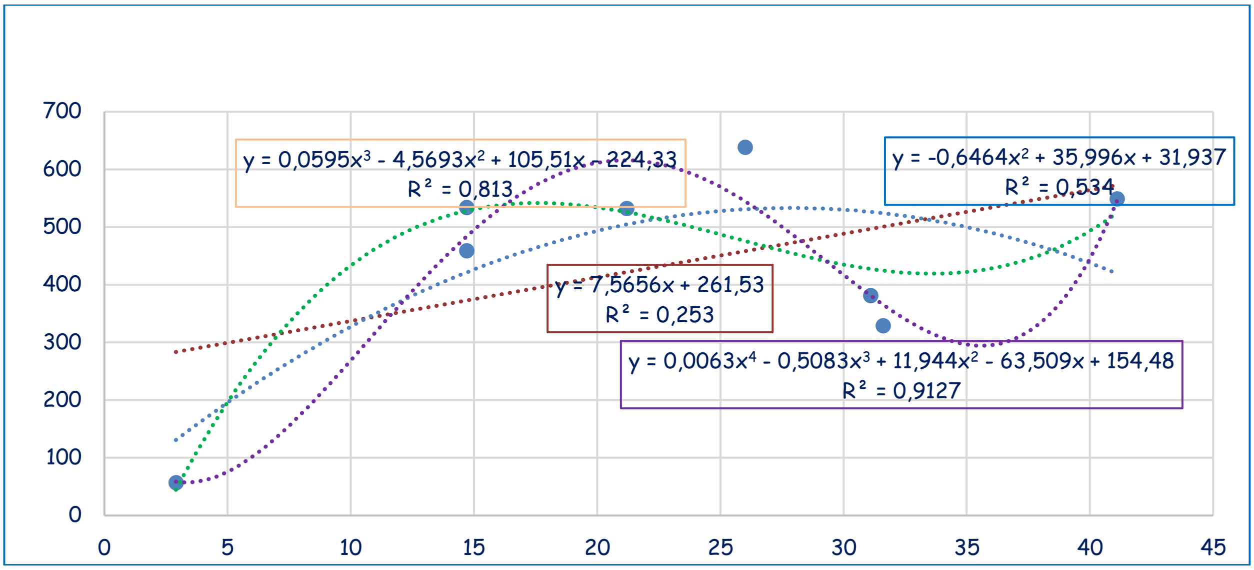


Fig. 4. The correlation between number of jobs created and the poverty rate
Source: Own design.

Another perspective to analyze to what extent through the jobs created contributed to the prosperity of the region, more specifically to the rural development of the LAG territory, is to analyze the correlation between the average value allocated at LDS, by region and the average of places created work. Table 5 shows the average value allocated in LDS, by regions as well as the average number of jobs created on each Local Action Group in each region. The highest average value allocated within the LDS is in the West region (2,501,067.33 euros) as well as the highest average of jobs created, 24.16. In B-Ilfov, the region with the lowest average allocated value of LDS, the average job created is 14.25. In the case of the two variables, it is observed that a clearly defined rule is not followed, the jobs created not being influenced, strictly by the average value of the financial allocation / LDS. This aspect is also reinforced by the values of the correlation coefficients in Table 6, as well as by the graphical representation of the polynomial function in Figure 5. The Pearson coefficient has a value of 0.4797, which according to Colton's* rules means that there is a moderate positive correlation between the two variables. From the point of view of the polynomial function, their degree 4 shows that there could be a direct positive correlation between the two variables.

Table 5. Average allocated value/LDS and average number of jobs created.

Region	Average value -LDS/LAG-euro	Average of created jobs/LAG
N-E	1,913,674.30	12.20
S-E	1,742,836.69	10.58
S-Muntenia	1,903,845.49	15.19
S-V Oltenia	1,959,025.97	11.75
V	2,501,067.33	24.16
N-V	1,864,654.69	17.23
Center	1,785,008.26	15.65
B-Ilfov	802,573.90	14.25

Source: Own processing according to data www.madr.ro accesed on 30.06.2021

Table 6. Table representation of the values of the correlation between the number of jobs created and the average of the allocated value / LDS

Correlation	r	R2	R2	R2	R2
Average of no of jobs created/Average of LDS value-LAG	Coef. Pearson	Linear function	Polynomial function - 2nd degree	Polynomial function - 3rd degree	Polynomial function - 4th degree
	0.4797*	0.2301	0.7034	0.7195	0.9401

Source: Own processing.

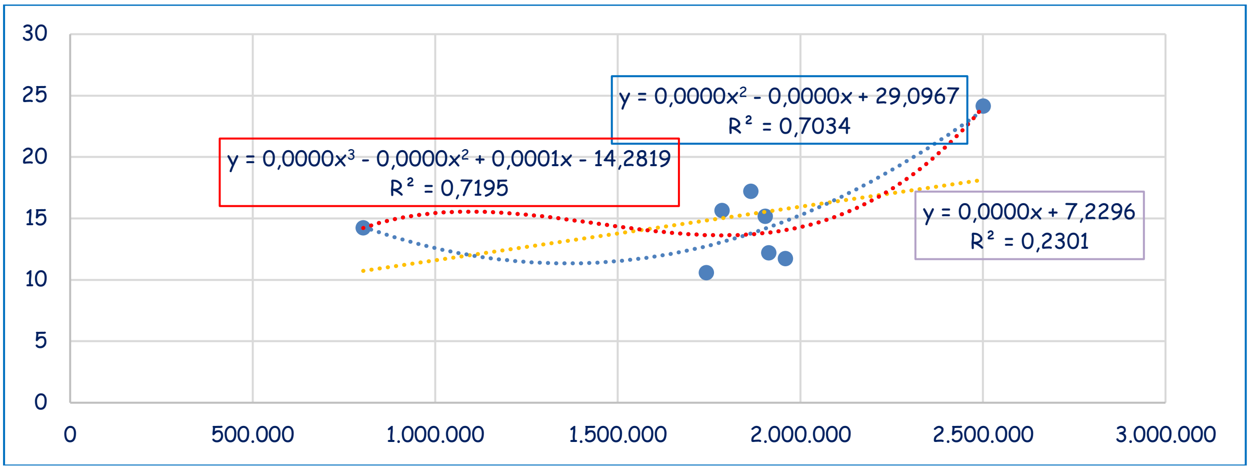


Fig. 5. The correlation between the average number of created jos and the average of LDS value/LAG, graphic design.

CONCLUSIONS

According to the analyzed data we can admit the positive contribution of the financing obtained by the Local Action Groups through measure 19 LEADER to the rural development of the financed regions. In the second stage of the bonus, the additional one, 146 local action groups were rewarded, more than half of their total, more precisely 61.08%. The additional bonus increased the LDS-19.2 budget, at national level by 21,308,364 euros. This aspect shows a good promotion of the measures within LDS as well as the interest of the community for development.

By absorbing the allocated funds, over 3,400 jobs have been created, maybe insufficient at the moment for the labor force needs in the respective rural community, but these are still a premise for evolution. In fact, the jobs created have contributed to the development of both the economic and the social component, many of the new employees coming from disadvantaged categories.

Moreover, the number of jobs, unequal at the level of each analyzed region suggests the application of one of the innovative principles of the LEADER approach, the "bottom-up" principle, respectively the dimensioning of the need starting from the preliminary analysis of the territory and, of course, depending on the allocation financial.

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ANALYSIS OF ECONOMIC INDICATORS OF AGRICULTURAL HOLDINGS SPECIALIZED IN RAISING DAIRY COWS IN ROMANIA. CASE STUDIES

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Abstract

Economic indicators are key elements that indicate the current situation and economic performance of farms. The purpose of the study is to determine the main economic indicators and to analyze them comparatively, to determine the economic efficiency of dairy farms, depending on their area. The obtained results indicate that the farms in the plain area have the largest size and production, but the farms in the hill area have the highest profitability threshold. Farms in the mountain area are the least profitable, the position of the farm and the high costs confirm the difficulties of economic development of many farms in the mountains.

Key words**:** *economic indicators, profitability, farms, dairy cows, Romania*

INTRODUCTION

According to studies, worldwide, 85% of total milk is obtained from cows, the remaining 15% being obtained from other species. Also, in the European Union, Romania ranks 10th in terms of milk consumption, with 266.19 kg/inhabitant, the first places being occupied by Finland (361.19 kg/inhabitant), Sweden (355.86 kg/inhabitant) and the Netherlands (320.15 kg/inhabitant) [10].

The fragmentation of the dairy sector strongly affects the Romanian dairy market, thus, by 2020, almost 80% of dairy cows were found in very small farms, 1-2 heads. Also, since 2009, the sector has been in a continuous decline, on the one hand due to the reduction of cattle herds and on the other hand due to climate change which has affected feed production [6], [7].

The whole animal sector has also been affected by the European health conditions imposed by the EU, as well as by the economic crisis that has affected domestic consumption of both meat and dairy products [3], [9].

Cattle and farms of private, family, associative, commercial type are of special socio-economic importance in agriculture, requiring increased attention [1].

Value imports of milk increased in 2017 by about 50.95% compared to 2014, and quantitative imports increased by 74.8% compared to 2014, while the value of production fluctuated from year to year between 2010 -2016 [2].

Regarding the profitability of production, it can be adjusted by reducing the cost of production, which can be achieved by purchasing fodder at lower prices, or by mechanizing work that requires a large volume of physical labor, such as milking or transporting fodder [8], [5].

The purpose of the study is to determine the main economic indicators and to analyze them comparatively, to determine the economic efficiency of farms depending on their area.

MATERIALS AND METHODS

The data collected and analyzed in this paper come from 54 agricultural holdings specializing in milk production, of which 24 from the plain area, 14 from the hill area, and 16 from the mountain area. Based on the data provided from the farms, it was possible to determine: their economic size, the different categories of expenses, the production cost, the production value, the profitability threshold, the exploitation risk rate, etc. In this paper, the average values calculated based on data from 2018-2020 were highlighted, grouped according to the relief areas.

The analyzed agricultural holdings are part of the counties: Teleorman, Ilfov, Călăraş, Olt, Arad, Iaşi, Prahova, Hunedoara, Botoşani, Sălaş, Cluj, Vâlcea, Gorj, Buzău, Maramureş, Alba Iulia and Sibiu.

RESULTS AND DISCUSSIONS

In the case of the analyzed farms in the plain area, 14 of them have an economic size between 8,000 and 49,999 SO, 9 farms have an economic size between 50,000 and 999,999 SO, and only one has a size between 2,000 and 7,999 SO, being part from the category of semi-subsistence farms (Table 1).

Table 1. Determining the economic size of farms by relief areas

Value S.O	Under 1,999 euro	2,000 - 7,999	8,000-49,999	50,000-999,999	Over 1,000,000 euro	TOTAL
Plain	0	1	14	9	0	24
Hill	7	0	4	3	0	14
Mountain	0	0	13	3	0	16
TOTAL	7	1	32	15	0	54

Source: Author's calculations.

In the hill area, out of the total of the 14 agricultural holdings analyzed, 7 of them have an economic size below 2,000 SO, 4 farms have an economic size between 8,000 and 49,999 SO, and 3 farms have a size between 50,000 and 999,999 SO (Table 1).

Analyzing the farms in the mountain area, we notice that the economic size between 8,000 and 49,999 euros predominates for 13 farms analyzed, and among those with an economic size between 50,000-999,999 euros, 3 farms were analyzed (Table 1).

Analyzing the size of the farms, depending on the size of the herds, an average of 103 heads is observed in the plain area, while in the hill area an average of 76 heads/farm were registered, and in the mountain area, on average 27 of heads/holding. In the case of the plain area, the herds ranged between 6 and 511 heads, while in the hill area, the herds ranged between 5 and 568 heads. Lowest size of herds cows were recorded in the mountain area, ranging between 7 and 27 heads (Fig. 1).

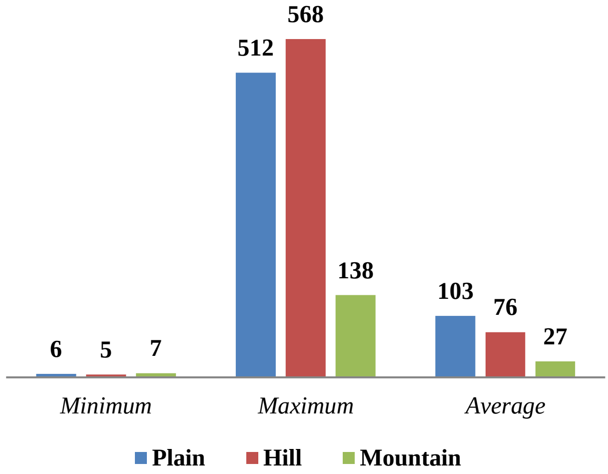

Fig. 1. Size of farms according to relief area (heads)
Source: Author's calculations.

It is observed that the average number of dairy cows in the mountain area (27 heads) is lower by 73% compared to the average number in the plain area (102 heads), respectively by 63% compared to the average number in the hill area (75 heads). The plain and hill areas have larger herds in terms of livestock, compared to the mountain area, due to the large grazing areas and those for cereals (Fig. 1).

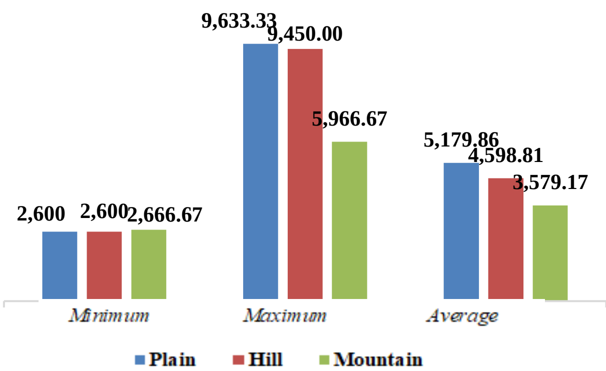

Fig. 2. Accent the average production by relief area (l/head)
Source: Author's calculations.

according to the data collected, the average production in the plain area ranged between 2,600 l and 9,633 l, with an average of 5,179 l/cow, showing values close to the average productions recorded in the hill area, between 2,600 l and 9,450 with an average of 4,598 l/cow (Fig. 2).

The total milk production oscillated in the plain area between 30.60 thousand l/farm and 4,929.06 l/farm, with an average of 711.30 thousand l/farm. It is observed that the total production registered in the hill area presents values close to those of the plain, thus the limits are between 27.90 l/farm and 5,370.75 l/ arm, with an average of 532.09 thousand l/farm (Fig. 3).

The average total milk production on the farm, registered in the mountain area was 120.24 thousand l/farm, lower by over 83% compared to the total production registered on the plain, respectively by over 77% compared to the average registered in the farm area. hill.

The average total milk production in the mountain area is much lower compared to the plain and hill area due to the small number of herds and the existing rustic breeds, with low productions (Fig. 3).

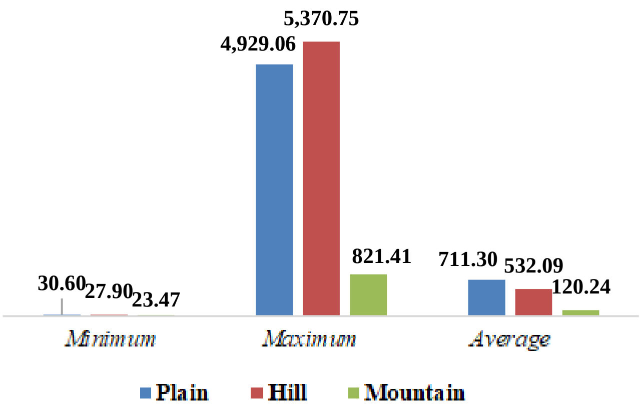

Fig. 3. Total milk production by relief area (thousand l/farm)
Source: Author's calculations.

In the hill region, the value of production was 1.85 lei/l, representing the highest average of the period between the 3 landforms analyzed, more than 14% compared to the average value of production recorded in the plain region and approximately 4% compared to the mountain region.

Table 2. Determination of the value of production, the value of main production and the capitalization price according to the relief area

Specification	Plain			Hill			Mountain		
	U.M: lei/l								
	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum	Average
Production value	1.29	2.70	**1.62**	1.34	3.81	**1.85**	1.46	2.73	**1.78**
The value of the main production	1.17	2.60	**1.48**	1.10	3.67	**1.68**	1.23	2.58	**1.59**
Capitalization price	1.17	2.60	**1.48**	1.10	3.67	**1.68**	1.23	2.58	**1.59**

Source: Author's calculations.

Regarding the limits of the production value, it is observed that they are higher in the mountain area, compared to the plain area, the minimum production value being 1.46 lei/l, and the maximum being 2.73 lei/l milk, in while in the plain area the limits are 1.29 lei / l and 2.7 lei/l of milk.

Regarding the capitalization price, it is observed that the average (1.48 lei/l) is lower by about 7% compared to the average price of mountain milk (1.59 lei/l). The high price of milk obtained in the mountain area, compared to milk obtained in the plain area is due to the higher cost of concentrated feed, transport costs, but also the capitalization of milk as a primary processed product on the farm (Table 2).

The break-even point is the point at which turnover covers variable and fixed operating expenses, calculated in physical or value units for a product or the entire activity.

Analyzing the profitability threshold on the 3 relief areas, for the analyzed farms, it is observed that the hill area has the highest average profitability threshold (9,661.42 lei), higher by 24.9% compared to the average profitability threshold registered in the plain area (7,735.99 lei) and by 37.5% compared to the average registered in the mountain area (7,026.06 lei). It is thus found that the farms in the hill area are more profitable compared to the farms in the mountain area, where the expenses are much higher, and where the economic results are negative (Fig. 4).

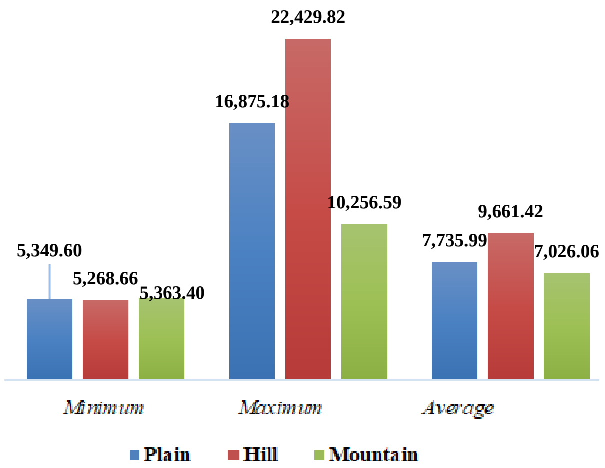

Fig. 4. Determining the break-even point in PR* value units according to the relief area (lei)
Source: Author's calculations
* break-even point.

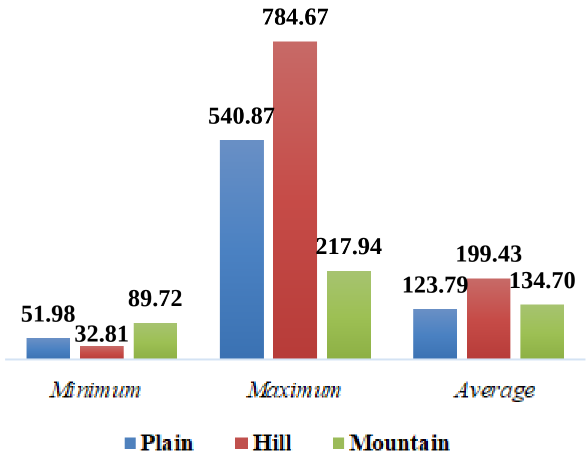

Fig. 5. Determination of the exploitation risk rate according to the relief area (%)
Source: Author's calculations.

The exploitation risk expresses the adaptability of the farm with the lowest cost to the variations of the economic conditions, such as the purchase prices, the accentuation of the competition, the loss of the sales market.
Analyzing the rate of risk of exploitation of farms in the 3 relief areas, it is observed that the average of this indicator in the hill area is 199.43%, 64.73% higher than the average recorded in the plain area and 64.73% compared to the mountain area (Fig. 5).

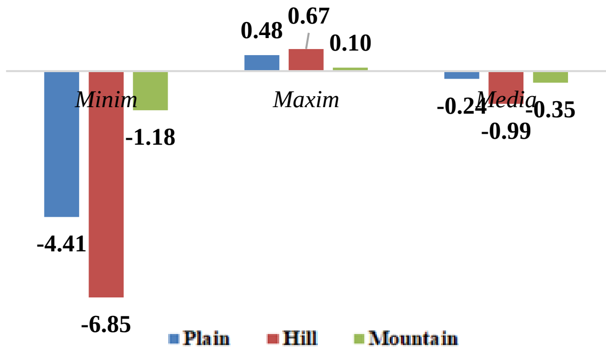

Fig. 6. Determination of the exploitation risk rate according to the relief area (%)
Source: Author's calculations.

Analyzing the security index on the 3 relief areas, it is found that the average for the 3 years analyzed is negative. Thus, in the hill area the lowest security index is registered, -0.99, being followed by the mountain area with -0.35, while the plain area has a security index of -0.24 (Fig. 6.).

CONCLUSIONS

The obtained results indicate that the farms in the plain area have the largest size and production, but the farms in the hill area have the highest profitability threshold. The farms in the mountain area are the least profitable. The position of the farm, as well as the high costs confirm the difficulties of economic development of many farms in the mountain area.
Although in terms of quality, milk from farms located in the mountain area is higher than that from the plain or hill area, mainly due to the food consumed by cows with high nutritional values, the size of dairy cows it is significantly lower than in the other two regions. Also, in these areas, transportation costs for materials, supplies, or delivery are higher, especially in areas with more difficult accessibility.
On average, agricultural holdings specializing in raising dairy cows in the plain area record higher yields than in the case of other

landforms, which is mainly determined by the farming system; thus, in the plain, intensive farms predominate, with cow breeds specialized in milk production.

When determining the profitability threshold, in farms in the hill area, this indicator shows significantly better values than in the case of farms in the plain and mountain area, as this area combines the advantages found in the other two areas, both by the existence of good breeds. milk producers, as well as through the possibility of capitalizing on the existing resources in the hill area (pastures and hayfields).

The creation of groups of producers or cooperatives in the dairy sector can probably be one of the best solutions to increase the profitability of these farms, especially among subsistence and small or medium-sized ones.

ACKNOWLEDGEMENTS

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CURRENT SITUATION OF ROMANIAN CERTIFIED PRODUCTS

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Abstract

Certification of agri-food products is a mechanism for consumer protection, providing confidence and product compliance. Certified products, depending on the type of certification and the shape of the relief, have unique characteristics such as safety and quality. In Romania, there are 1,201 certified products of the mountain product type, Vâlcea County holding a share of 15.9% of the total products at national level. There are 641 products of traditional product type, concentrating in Transylvania, Muntenia and Maramureș, Brașov county holding the share of 27% of the total products of this type certified nationally. There are 141 products of the established recipe type, and the products certified as Certified Wines are 130 products, concentrated in the sub-Carpathian area, due to the wine-growing areas owned.

Key words: *certification, agri-food, food safety, Romania*

INTRODUCTION

According to Pădure (2019), quality has become a strategic tool for producers, which consumers evaluate according to the level of quality that producers attribute to the product in different aspects: meeting quality standards, hygiene, ingredients, nutritional values, packaging [10].
Certification is an important aspect of the economic point of view for the producer, giving consumers confidence, the food sector being based on quality, organization and control [8], [2].
Food safety is an important feature of quality and must be an objective, a major responsibility of food producers. Food security is a disorder for some countries, standards intensify both strengths and weaknesses [12], [3].
Certified mountain products can be real opportunities for mountain producers. Due to the obtained products, which have superior characteristics compared to other products obtained in other relief areas, by certification, the products obtain higher added value, and the promotion can be achieved much easier [6], [7].
Certification of organic products can be a model for encouraging sustainable agriculture, helping to improve biodiversity and adapt to climate conditions [9].
According to Rabontu (2009), in the last decade, consumers are increasingly expressing their concern for food safety, being more and more interested in the origin of raw materials. The diversification of products on the market makes it difficult for consumers to understand, the results being felt by illness caused by poor nutrition [4], [11].
Geographical indications are basic tools, which offer property rights in relation to certain products, being regulated at the level of the European Union. Quality is a subjective term, the actors involved in the whole product chain may perceive and interpret quality differently, for consumers being closely related to meeting expectations regarding the product consumed [12].
The quality schemes for agri-food products encountered in the European Union are:
-Protected Designation of Origin (PDO) - the PDO is regulated by Regulation (EU) no. 1151/2012, which provides for the use of the geographical name and which aims to establish the criteria and the procedure for registration of products.

-Protected Geographical Indication (PGI) - Protected Geographical Indication is the name that identifies a product from a specific region, country, place. Products bearing the PGI logo must be associated with the geographical area and have characteristics specific to the area of origin. The raw materials used to obtain PGI products may have origins other than the established geographical area.

-Traditional Specialty Guaranteed (GSP) - are based on distinctive features based on traditional ingredients, as well as traditional methods of obtaining products.

-Mountain product - Products that benefit from the quality scheme called Mountain product must meet several conditions in force with European legislation.

-Organic products - Organic production involves best practices for the environment, conservation of natural resources and maintaining animal welfare.

-The product of the EU's outermost regions - The nine outermost regions, although thousands of kilometers away, are an integral part of the European Union. These regions benefit from specific measures, which support access to the internal market for economic growth [5].

The aim of the paper is to identify the geographical distribution of certified Romanian products with the role of identifying areas where these products are not certified and recognizing the reasons behind this, in the context in which such products can contribute to increasing incomes of agricultural producers who choose this type of certification.

MATERIALS AND METHODS

The paper is based on data provided by the Agency for Financing Rural Investments (AFIR) and the Ministry of Agriculture and Rural Development (MADR) through the application Catalogue of Certified Food Products (CPAC) that helps consumers to easily identify producers whose products are product certificates certified qualitatively, but also comes to the aid of economic agents, who can certify their products through the application. How to register a certified product is very easy. After creating an account, which involves entering an email, a password, and then a confirmation of the email, the manufacturers find all the necessary documents to complete in the application. After uploading the necessary documents, the producers are informed of each stage of the dossier submitted.

The research used the histogram method, which aims at the frequency and presentation of data. Also, using the comparative data method, it will be possible to identify information on development trends.

RESULTS AND DISCUSSIONS

According to the data provided by AFIR, in Figure 1, the products certified with the type of Traditional Product attestation in 2020 are represented geographically, so that at national level 641 products are registered.

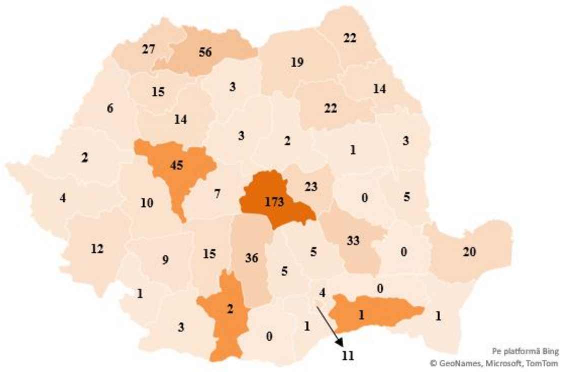

Fig. 1. Number of products certified with the type of certification as a Traditional Product
Source: Own processing based on AFIR data [1].

Most traditional certifications are registered in Brașov County with 173 products, in which the category of dairy products (59 products), the category of meat products (59 products) and bakery products (14 products) predominate. It is followed by Maramureș County, with a total of 56 certified products, of which 25 are part of the meat products category, 11 of the bakery products category, and the dairy products are 6. There are 45 products registered in Alba County. traditionally certified, the products in the bakery category number 27, and the products

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in the vegetable-fruit category number 8 (Fig. 1.)

In Romania, the products certified according to the established recipes, number 141, these being found in the largest proportion in the North-East and Central region of the country.

In Ilfov County, 16 products certified according to traditional recipes were registered, all falling into the category of meat products. In Argeș County, 15 certified products are registered, 13 are part of the meat products category and 2 are in the bakery products category. Sibiu County presents 5 products certified according to established recipes, 2 are part of the category of bakery products, one product in the category of vegetables and fruits and one in other categories (mustard) (Fig. 2).

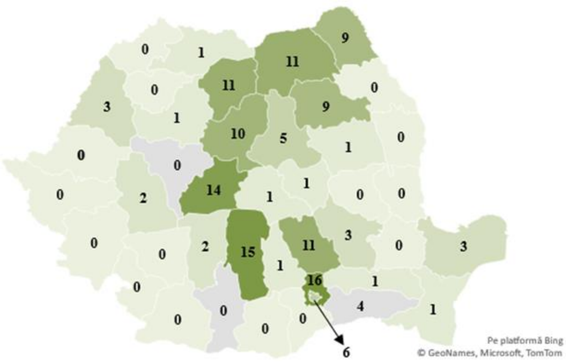

Fig. 2. Number of products certified with the type of certification as Recognized Recipe
Source: Own processing based on AFIR data [1].

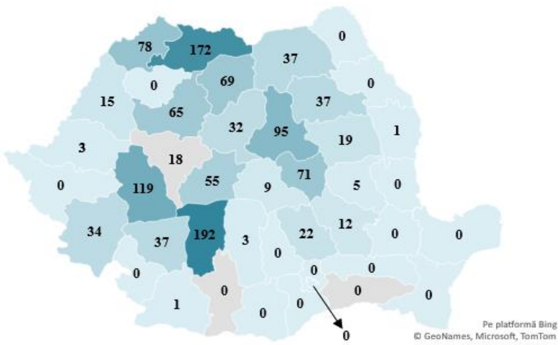

Fig. 3. Number of products certified with the Mountain Product certification type
Source: Own processing based on AFIR data [1].

There are 1,201 certified products as a Mountain Product, most of them being located in the Center, North-West of Romania and South-West-Oltenia.

Vâlcea County produces the most products certified with the type of attestation Produs Montan, 115 falling into the category of fruits and vegetables, 40 products in the category of bee products and 37 in the category of dairy products. (Fig. 3).

Maramureș County has 172 products registered as a mountain product, highlighting the category of fruit and vegetable products (166 products), followed by bee products (4 products) and dairy products (2 products) (Fig. 3).

Prahova County has the most certified wines, 24 in number, followed by Vrancea County with 11 certified wines and Arad and Constanța counties with 10 certified wines, highlighting specific areas with a tradition in vine cultivation.

Products certified with Protected Geographical Indication, are found in 11 products, included in the category of meat products (5 products), dairy products (2 products), fish products (3 products), fruit and vegetable products (one product).

In Romania, only one product is registered with the type of Protected Designation of Origin certification, included in the category of dairy products located in Mureș County (Fig. 4).

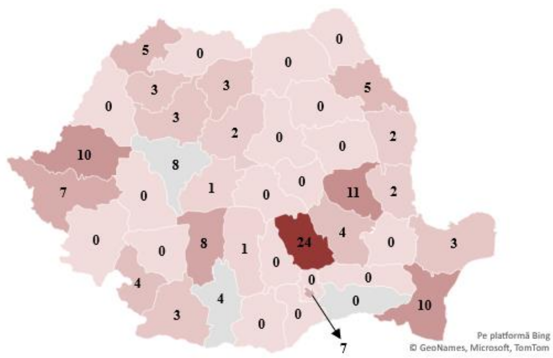

Fig. 4. Number of products certified with the type of certification Certified wines
Source: Own processing based on AFIR data[1].

It is observed that following the analysis, the certified products of mountain type have the most certified products in number of 1,201, Vâlcea County holding the largest share of 15.99% of total certified products in Romania, thus, mountain products concentrating only in mountainous areas. The certified products of the type of products certified as Traditional Product are in number of 641 products in

2021, most of them concentrating in Transylvania, Muntenia and Maramureș. Brașov County has the most certified products, representing approximately 27% of the total products at national level (Table 1).

Table 1. Centralizing situation according to the type of certified products

Tip	TOTAL	County maximum value	% out of the total	Number of counties without no certified product
P.T.	641	173	**26.99**	4
R.C.	141	16	11.35	16
P.M.	**1201**	**192**	15.99	16
V.C.	130	24	18.46	**19**

Source: Own processing based on AFIR data [1].

It is observed that in the case of these types of certified products, there are 4 counties that do not present certified products, although the coverage area could be much wider.

There are 130 certified products of the Certified Wines type in Romania, most of them being concentrated in the part of the sub-Carpathian area, due to the wine-growing areas owned. Prahova County (24 products), has a share of 18.46% of the total certified products such as Certified Wines, and 19 counties without any certified product.

The products of the established recipe type present 141 products at national level, these being concentrated in Transylvania, Muntenia and Bucovina. Prahova County is in the top of the ranking, holding 11.35% of the total certified products of this type, 16 counties not holding any certified product (Table 1).

CONCLUSIONS

Certified products have superior characteristics depending on the relief area in which the products are made, and due to the characteristics held, increased attention is required for promotion.

According to the Agency for the Financing of Rural Investments, Romania has an application that makes available to consumers, a certified product, distributed by counties according to their type. In the case of products certified as a traditional product, Romania currently has 641 products, at the top of the ranking is Brașov County with 173 mountain products. For the products from the established recipe category, their total in Romania is 1201 products, in the Center, North-West of Romania and South West-Oltenia being located the most certified products. For the category of certified wine products, in Romania there are 130 certified products, Prahova county has the most certified wines, in number of 24. The certified products as Mountain Product are in number of 1201, the most locations are in the Center, North-West Romania and South-West-Oltenia.

Clearly, the attestation of these products by agricultural producers can help to increase the income obtained by them by providing a guarantee of the quality of the product marketed to consumers. The type of attestations differs from one area of the country to another, and from one form of relief to another, depending on the pedoclimatic conditions of the raw products obtained. For example, there is a concentration in the sub-Carpathian area, an area known for its vineyards, but in the case of products certified as a consecrated recipe, many counties are identified in which no such product is certified. This is mainly evident in the plain areas, where farmers are interested in obtaining large yields in terms of quantity, to the detriment of processing and obtaining a finished product.

Romanian products, respectively certified product have a higher price, accessibility in supermarkets/hypermarkets being difficult.

Following the location of the products, there is a link between small and medium-sized farms and certified products. By making products certified by farmers, they can increase their added value and can be a strategy for selling products, improving the image of the farm and diversifying their production. The high potential that is presented by each region, requires the implementation of cooperatives that can deal with the marketing of certified products depending on location. There is also a need to promote certified products that promote

authentic and natural products, health comes first when certified products are made.
Coming to the aid of producers, sub - measure 3.1. Support for participation for the first time in quality schemes, the sub-measure provides non-reimbursable financial aid of EUR 3000 for one holding per year, contributing to market integration. The strategy for the development of the agri-food system 2020-2030 also comes to the aid of producers, supporting certified products, providing support to promote product certification and training farmers to meet environmental challenges.

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THE IMPACT OF DIGITALIZATION ON COMPETITIVENESS OF BULGARIAN AGRICULTURE

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Abstract

Digitization is the key topic of our time. The impact of new technologies has a huge potential especially in Bulgarian agriculture. In the conditions of the COVID-19 and financial crisis, Bulgarian agriculture faces a difficult choice – farmers have to make serious investments in digitalization in order to be able to meet the European requirements related to food quality and environmental protection. The purpose of this article is to present and analyze the impact of digitalization on competitiveness of agricultural sector in Bulgaria, and to outline the direction related to the proper use of technologies for the rapid development of Bulgarian agriculture. The study is based on the documentation method which made of laws and regulations in the sphere of agriculture, as well as specific legislation related to digitalization. In the conditions of the COVID-pandemic which has accelerated the process of digitization and support for farmers who introduce digital technologies, innovative technologies for production and organization in agriculture, in order to increase the competitiveness of the agricultural sector in Bulgaria.

Key words: *digitalization, competitiveness, agriculture, Bulgaria*

INTRODUCTION

Digitization is the key topic of our time. The influence of new technologies has a huge potential in almost all walks of life and industries – especially in agricultural sector. Digitization in agriculture could help farmers optimize their costs and achieve greater profitability, which is of vital importance in the background of our modern environment characterized by low production prices and ever-increasing rents and wages [3].

Digitalization allows the agricultural sector to realize its potential, adding value while increasing farmers' income and quality of life. Currently, in Bulgaria, average farms of 5,000 to 10,000 decares are the most innovative ones. The main reason for this fact is that small farms cannot afford the deployment of new technologies, while large farms rely mostly on their volumes of margin [5].

In this context, the purpose of this article is to present and analyze the status and impact of digitalization on competitiveness of agricultural sector in Bulgaria, and to outline the direction related to the proper use of technologies for the rapid development of Bulgarian agriculture.

MATERIALS AND METHODS

The study is based on the documentation method which made of laws and regulations in the sphere of agriculture, as well as specific legislation related to digitization comprising the following regulations: Act on Ownership and Use of Agricultural Land; Law on Restoration of Ownership of Forests and Land from the Forest Fund; Regulations on the Implementation of the Act on Ownership and Use of Agricultural Land; Regulations on the Implementation of the Law on Restoration of Ownership of Forests and Land from the Forest Fund; Forestry Act; Agricultural Lease Act; Law on aid to farmers, etc.

The most important strategic documents for Bulgaria, on the basis of which the political framework in the sphere of information and communication technologies is formed, are the following ones as mentioned by [2]:

-The updated Electronic Communications Policy of the Republic of Bulgaria 2015-2018 for development of communications and

achievement of a rapid economic growth within the Single European Market;
-The Strategy for development of e-Government in the Republic of Bulgaria 2014 -2020;
-The Smart Specialization Innovation Strategy of the Republic of Bulgaria (2014-2020);
-The National Cyber Security Strategy, *Cyber Resilient Bulgaria* 2020;
-Strategy for Digitization of Agriculture and Rural Areas in Bulgaria – 2019.

RESULTS AND DISCUSSIONS

Following the accession of our country to the European Union in 2007, until 2018 more than BGN 1 billion were invested in the modernization of farms under the European Agricultural Fund for Rural Development in Bulgaria [9].
Currently, the funds spent entirely for investments in digital solutions and precision farming technologies are exclusively private in nature and depend on the economic opportunities of the individual agricultural farm or entrepreneur. Therefore, at a national level there is a lack of overall information on the investments made so far, the level of digitization achieved and the technologies available for precision farming [7].
The Rural Development Program gives priority to assessment of projects that include up to 30% cost on digitization of farms. The focus of the Agricultural Modernization Fund, which forms a key part of the National Recovery and Sustainability Plan, focuses on digitalization, sustainable agriculture and digital connectivity [4].
According to Vladimir Nikolov, farmers' fear of trusting new technologies is a major obstacle to the digitization and implementation of innovations in agriculture [1].
In the presented methodological approach for assessing the impact of digitalization on the competitiveness of agricultural farms three analytical tools play a vital role:
-Driver that measures the level of digitalization in the agricultural farm;
-Marker that measures the effect of digitalization on the competitiveness of the agricultural farm;
-Indicator that measures the level of competitiveness of the agricultural farm.
In order to establish an efficient and better working agricultural farm in different agricultural industries, it is necessary to provide the required investments.
For example, for fruit and vegetable farms, it is necessary to invest mainly in processing and harvesting machines. This is necessitated by the difficulty in finding workers in agricultural areas [10].
There are already sensors on the market that monitor the maturity of fruit and vegetables in order to achieve optimal harvesting.
There are machines that allow for almost automated harvesting and they are an absolute must for more efficient farming [7].
In particular, digitalization of agriculture will increase farmers' incomes; it will also improve the quality of production according to consumer requirements and will reduce production costs [7].
The data in Table 1 clearly outline the increase in the share of people in Bulgaria who use the Internet for interaction with public institutions from 17.8% in 2015 to 26.9% in 2020.
This trend is even more noticeable in the conditions of the COVID-pandemic which has accelerated the process of digitization and support for farmers who introduce digital technologies, innovative technologies for production and organization in agriculture, computerization of workflow processes, etc., in order to increase the competitiveness of the agricultural sector in Bulgaria.
Digitization of agriculture leads to greater efficiency of agricultural farms, improves environmental protection and sustainability, animal welfare and, in particular, grants more transparency for consumers [1].

Table 1. Persons using the Internet for interaction with public institutions (%)

	2015	2016	2017	2018	2019	2020
Total	17.8	18.4	20.7	22.2	25.4	26.9
A. By sex						
Men	16.6	17.3	19.8	21.8	24.5	26.5
Women	19.0	19.5	21.6	22.7	26.4	27.4
B. By types of purposes						
-To obtain information from a website or application of a public institution	16.0	15.0	14.7	17.1	19.8	19.0
Men	14.8	14.0	14.1	17.0	18.9	18.9
Women	17.2	16.0	15.3	17.1	20.7	19.1
-To download official documents, forms, declarations or reports	12.9	9.3	10.4	9.4	12.5	14.4
Men	11.9	8.3	9.4	8.9	11.6	13.6
Women	13.9	10.4	11.4	9.8	13.3	15.1
-To submit on-line official documents, forms, declarations or reports	9.1	6.5	8.3	9.5	10.2	15.0
Men	8.2	5.9	7.3	9.0	8.9	14.2
Women	10.0	7.1	9.3	9.9	11.4	15.8

Source: National Statistical Institute, 2021 (NIS) [8]

The field studies were carried out on the basis of primary data - we used the data from the the Strategy for Digitization of Agriculture and Rural Areas in Bulgaria, Ministry of agriculture and Food. Around 260 farmers of different types of agricultural holdings were interviewed about their readiness to introduce digital technologies on their farms. Figure 1 clearly outlines the following results: 22% of the farmers report an increase in efficiency, 17% report a decrease in production costs, 16% - better planning and management, 14% - report an increase in productivity, 9% report maintaining competitiveness, 4% - increasing turnover, 2% say that added value has increased, while 1% do not see the benefit of the introduction of digital technologies.

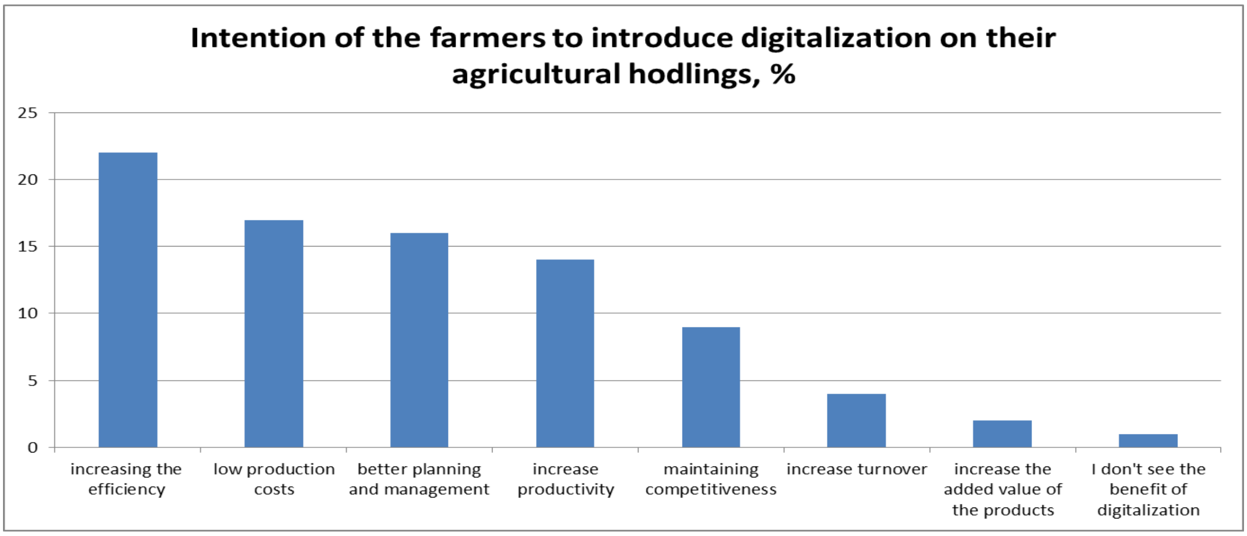

Fig. 1. Intention of the farmers to introduce digitalization on their agricultural holdings, (%)
Source: Own design based on the Strategy for Digitization of Agriculture and Rural Areas in Bulgaria, Ministry of agriculture and Food, 2019.

The analysis of the presented data shows that only 4% of the producers intend to invest in digitalization of the process, 10% plan to do so, while 86% intend to invest no more than 10% of revenues.

In our country there is a significant difference in the level of digitization in the agricultural sub-sectors, farms of different juridical type and size, as well as in different regions in Bulgaria [11]. A large part of agricultural farmers are unaware of the nature of digital farming, with only 14% using modern digital technologies [7]. The main challenge for Bulgaria is to support agricultural farms to successfully cope with the implementation of modern digital technologies in agriculture in order to increase the competitiveness of Bulgarian agriculture [6].

CONCLUSIONS

Bulgaria is comparatively small both in territory and population. By tradition, agriculture has been a major sector of Bulgarian economy because of its crucial social and economic significance. In the conditions of the COVID-19 and financial crisis, Bulgarian agriculture faces a difficult choice – farmers have to make serious investments in digitalization in order to be able to meet the European requirements related to food quality and environmental protection. The key objectives of digitization of Bulgarian agriculture are related to the increase of productivity and competitiveness of agricultural production and promotion of the interest and attraction of young farmers to engage in agriculture. The opportunities for increasing the competitiveness of Bulgarian agriculture are revealed by means of the effective process of digitization. The resources to achieve the European level of digitalization can be identified in different areas: rapid deployment of technological solutions and modern innovations developed by scientific organizations; promotion of good agricultural practices; enhancing the national support for the Bulgarian agricultural sector.
Bulgaria lags significantly behind the rest of the EU member states in terms of the implementation of digital technologies in the economy and agriculture.

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ASPECTS THAT CONTRIBUTED TO CHANGES IN THE PRICE OF AGRICULTURAL LAND IN ROMANIA AND OTHER COUNTRIES IN THE EUROPEAN UNION

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Abstract

This paper presents the comparison between Romania in relation to countries such as Poland, Italy, Germany, Hungary and Bulgaria, taking into account the similarities between them in terms of selling price of agricultural land, size of countries and agricultural area used. Current differences observed between the sale price of land in Romania, clearly express that there are various problems of agricultural activity in Romania. At the end of the paper, a model was created to see if there is a statistically significant linear relationship between the price of land the number of farms and the subsidy offered per hectare. The purpose of this paper is to identify and verify the correlation between the increase in selling prices of agricultural land, the number of farms and the single payment scheme per hectare. Germany ranks first among countries in terms of agricultural area, holding approximately 16.67 million hectares in 2020, with a negative growth rate of 0.04% while the only country with a positive growth rate is Italy, 0.47%, with a total agricultural area of 13.15 million hectares in 2019. In Romania, the price of one hectare of land is 5,339 euros and it is expected that the prices of agricultural land will increase in the coming years. Rising farmland prices can have a positive impact due to the European Union's financial support for the agricultural sector and agricultural activities.

Key words: *land price, agricultural area, agricultural land, Romania*

INTRODUCTION

Romania is the country with the largest number of agricultural holdings among the 6 countries selected and analyzed in this study: Poland, Italy, Germany, Hungary, Bulgaria and Romania. But, compared to the other five countries, Romania has the lowest price offered per hectare of agricultural land.

The position of Romanian agriculture today is largely influenced by the agricultural structure of the country, this being one of the most important problems facing Romania.

From a demographic point of view, Romania's population represents approximately 4% of the EU-28 population, with a total country size of 238,397 km^2. In terms of agricultural area used, Romania is among the main EU countries, owning approximately 13.83 million hectares representing 60.7% of the country's area, while Germany has 16.67 million hectares, Italy 13.15 million hectares and Poland about 15 million hectares (48.2% of the country's area).

There are numerous studies that address the issue of agricultural land and their prices. For example, Virgilijus Rutkauskas, in his paper entitled "Explaining changes in agricultural land prices - a study of Lithuania" argues that the factors that contribute to changes in agricultural land prices are mainly divided into two categories: income from land use and alternatives their use [9]. Regarding the income obtained from land use, he claims that "the price is determined by the value of economic goods created by working the land itself." The same study argues that the current value of agricultural land should take into account several factors such as: characteristics of agricultural land, fertility, predominant agricultural structures, such as small farms or farms, distance between land and populated areas, etc [4, 10].

Alden Wily in his book "Collective Land Ownership in the 21st Century: An Overview of Global Trends" noted that unlike real agricultural land use, land ownership is a social element. He argues that "land ownership is significant for both state-building and economic development" [1].

In this context, the purpose of the study was to present a comparative analysis of the main indicators in Romania, Poland, Italy, Bulgaria, Germany and Hungary, including the link between the price of land and the number of holdings as well as the link between the price of land and the subsidy per hectare.

MATERIALS AND METHODS

In order to carry out the research, the selected countries were chosen for their similarities in terms of size, population, agricultural area, but also climatic conditions, relief, etc.

The indicators presented and analyzed in the research refer to the agricultural area of the countries, the selling prices of agricultural lands, both at the level of the development regions in Romania and at the level of the 6 countries and the presentation of the number of farms.

It is also noted that the analysis of the above-mentioned indicators was carried out for the period 2011-2019, and the latest data provided by Eurostat and the Structural Survey on Agriculture were used to analyze the number of holdings. At the end of the paper, a Pearson correlation model was made to show the connection between the variables. The correlation analysis involves measuring the intensity of the connection between the two numerical variables presented, as well as testing their significance, using SPSS program.

The correlation coefficient is calculated using the relation:

$$r = M\left(\frac{x-a}{\sigma_x} \ x \ \frac{y-b}{\sigma_y}\right),$$

where:

-M is the operator of the mean value,

-a = Mx and b = My are the centers of the distributions of the variables x and y, and

- σ_x and σ_y are the corresponding standard deviations.

The values recorded by the correlation coefficient "r" are between +1 and -1. If r = 0 there is a zero correlation.

RESULTS AND DISCUSSIONS

Romania, Italy, Germany and Poland are countries that have significant agricultural land in terms of size.

According to Table 1, Germany ranks first among countries in terms of agricultural area, holding approximately 16.67 million hectares in 2020, with a negative growth rate of 0.04%. The only country with a positive growth rate is Italy, 0.47%, with a total agricultural area of 13.15 million hectares in 2019, representing about 47.1% of the total area of the country (Table 1).

Table 1. Agricultural area used by the selected EU countries during 2011-2019 (million ha)

Country	2011	2012	2013	2014	2015	2016	2017	2018	2019	Growth rate (%) *
Germany	16.72	16.67	16.70	16.72	16.73	16.66	16.69	16.65	16.67	-0.04
Poland	14.78	14.53	14.41	14.42	14.40	14.41	14.50	14.54	14.55	-0.20
Romania	13.98	13.73	13.90	13.83	13.86	13.52	13.38	13.41	13.83	-0.14
Italy	12.67	12.55	12.43	12.72	12.66	12.84	13.01	12.91	13.15	0.47
Hungary	5.34	5.34	5.34	5.35	5.35	5.35	5.35	5.34	5.31	-0.07
Bulgaria	5.09	5.12	5.00	4.98	5.01	5.02	5.03	5.03	5.04	-0.12

Source: Eurostat, Accessed on 12.04.2021, * own calculations.

Regarding the development regions within Romania, the highest prices are registered in Bucharest-Ilfov and South-West Oltenia (Table 2). A higher concentration of outlets as well as their importance in the process of marketing agricultural and food products contributes to higher competition in demand for agricultural land in the Bucharest-Ilfov region, and consequently, the existence of above average land prices. Higher prices for agricultural land are also recorded in the southern and south-western regions of the

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country, mainly due to the high agricultural potential and fertile areas favorable to agriculture.
The price of land can be influenced by factors such as the region in which it is located, the quality of land, agricultural production prices and a number of national rules (laws), regional rules (climate, proximity to sales centers) and the relationship between supply and demand and so on an important role in determining the prices of agricultural land is also played by the degree of their merging, so that the more compact the area, the higher the selling price. A fair price contributes to the development of agriculture as well as to the improvement of transactions in the land market [6].

Table 2. Evoluția prețurilor terenurilor agricole în funcție de regiunea de dezvoltare in Romania (euro/ha)

Region	2011	2012	2013	2014	2015	2016	2017	2018	2019	Growth rate (%) *
TOTAL	1,366	1,666	1,653	2,423	2,039	1,958	2,085	4,914	5,339	18.58
North-West	1,085	1,572	1,234	2,292	2,046	1,906	2,022	4,181	4,921	20.80
Center	997	1,131	1,731	-	2,026	1,870	2,256	5,051	6,895	34.46
North-East	1,190	1,331	-	1,888	2,083	2,033	1,961	3,849	4,036	15.64
South East	1,387	1,776	1,518	2,929	1,999	1,863	2,028	5484	5448	18.65
South - Muntenia	1,347	1,345	1,791	2,111	2,048	2,059	2,227	4688	5833	20.11
Bucharest - Ilfov	1,415	466	1,577	1,781	1,783	1,999	1,958	7378	7394	22.96
Southwest Oltenia	1,240	1,270	1,936	2,205	2,007	1,966	2227	5730	5591	20.71

Source: eurostat.eu, accessed on 12.04.2021 [7], * own calculations.

A forecast of land prices for the next three-year period, 2020-2022, was made based on data provided by Eurostat (2010-2019), using the forecasting function in SPSS.
It is expected that the prices of agricultural land will continue to increase in the coming years, according to Figure 1, reaching in 2022 that one hectare of agricultural land will be sold with a maximum of 8,900 euros (Fig.1).

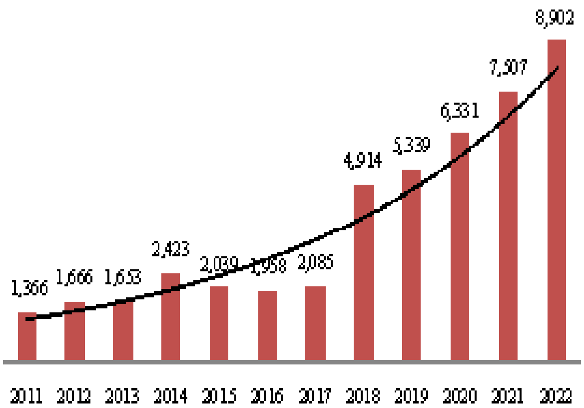

Fig. 1. The evolution of the land price in Romania, including the estimation until 2022 (euro/ha)
Source: own processing.

Figure 2 shows the evolution of agricultural land prices in the countries presented, Romania, Hungary, Bulgaria, Poland and Italy, in the period 2011-2019, where it is found that there were increases for the price of agricultural land. (Fig. 2).

The differences between the selling prices of land in Italy and the selling prices of land, in other countries can be attributed to the fact that Italy has been part of the European Union since 1958, benefiting from the financing of the agricultural sector long before Romania, Bulgaria, Poland and Hungary.
In other words, after Romania joined the European Union in 2007, the interest for investments in agriculture increased, due to the funds granted by the European Union for a development and improvement of farms, producer groups, for the development of irrigation system, afforestation, etc., thus increasing and the interest in cultivating the land, and implicitly, the price of agricultural land.
Italy is the only country with a negative annual growth rate,0,4%, ehile for the other countries, the growth rate has positive values.
The selling price of agricultural land in Romania increased on average by 18.58% euro/ha, reaching in 2019 that one hectare of agricultural land be sold, on average by 5,339 euro, according to data provided by Eurostat.
This was the strongest increase in land prices in 2011-2019 among the countries analyzed. 8 years ago, a hectare of land could be bought on average for only 1,366 euros (Table 3).

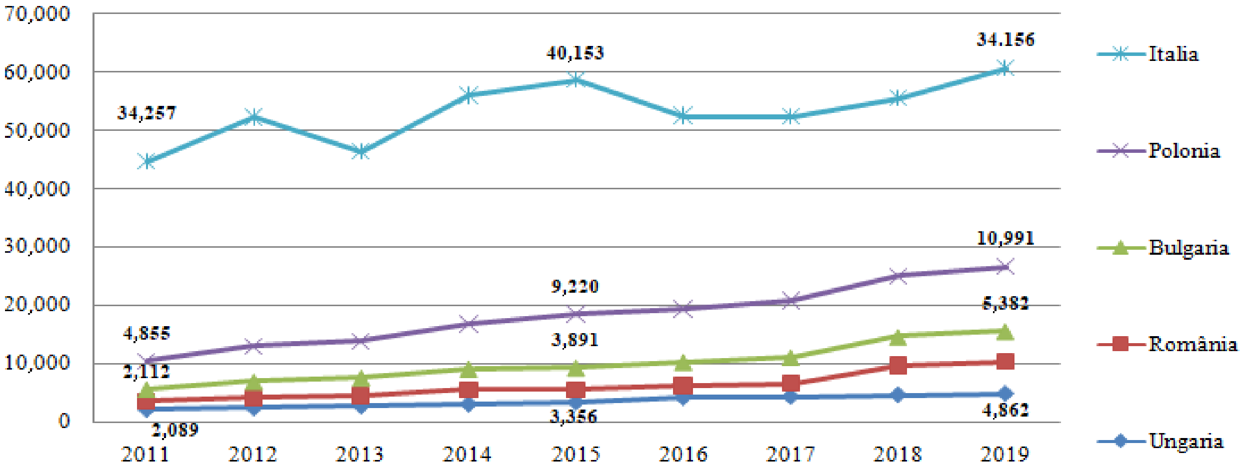

Fig. 2. Evolution of agricultural land prices in the selected EU countries (euro/ha)
Source: Eurostat.eu [7], accessed on 12.04.2021

Table 3. Evolution of agricultural land prices by selected country (euro/ha)

Country	2011	2012	2013	2014	2015	2016	2017	2018	2019	Growth rate (%) *
Hungary	2,089	2,380	2,709	3,042	3,356	4,182	4,368	4,662	4,862	11.14
Romania	1,366	1,666	1,653	2,423	2,039	1,958	2,085	4,914	5,339	18.58
Bulgaria	2,112	2,843	3,175	3,620	3,891	4,131	4,622	5,011	5,382	12.40
Poland	4,855	6,080	6,275	7,723	9,220	9,083	9,699	10,414	10,991	10.75
Italy	34,257	39,342	32,532	39,247	40,153	33,193	31,731	30,569	34,156	-0.04

Source: Eurostat.eu [7], accessed on 12.04.2021, * own calculations.

Romania is characterized by small farms, respectively by a very small average farm area.

According to the data provided by Eurostat, in 2016 (the most recent data), the farms in Romania were the smallest in terms of farm size, among the 6 countries analyzed (Fig. 3).

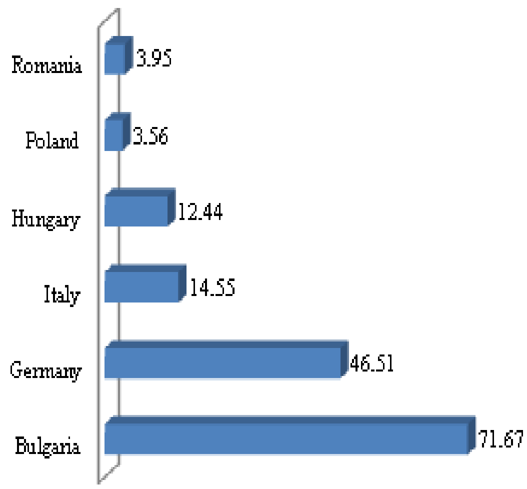

Fig. 3. The average size of farms in 2016 (ha)
Source: Eurostat data processed [7], accessed on 12.04.2021.

The reason why Romania has an average farm area well below Germany or Bulgaria, is due to the lack of the process of collectivization and land consolidation, which was not as complete as in other European countries [3, 10]. The process of concentration and merging of farms is a natural one, in close connection with the development and emergence of new, more efficient agricultural technologies.

With the emergence of high-performance production systems, which predominate in highly industrialized countries, there was the disappearance of small farms that could not expand, therefore, Romania is still dominated by small farms [5, 8].

Regarding the number of holdings in the analyzed countries, it is observed that Romania has the largest number of agricultural holdings (3.4 million) followed by Poland and Italy with a comparatively smaller number (1.4 million holdings respectively 1.1 million agricultural holdings), although the agricultural area used of these is higher compared to the agricultural area used in Romania (approximately 13 million hectares) (Fig. 4).

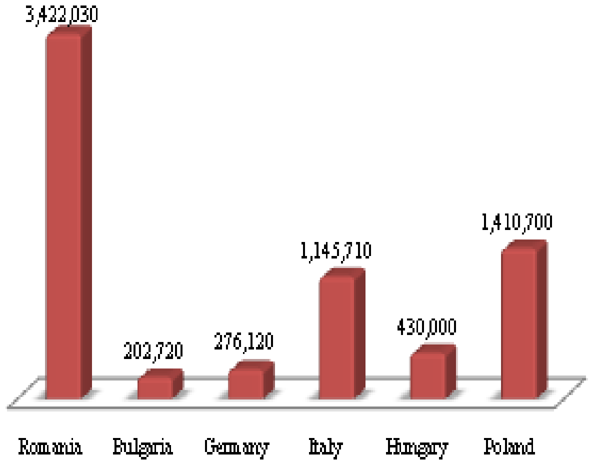

Fig. 4. Number of agricultural holdings in several European countries * (number)
* the latest data according to the Structural Survey in Agriculture 2016.
Source: Eurostat.eu [7], accessed on 12.04.2021.

Analyzing the link between the dependent variable "land price" and the independent variable "number of holdings" shows a close link. The value of the Pearson coefficient is –0.791, which indicates an inversely proportional link, meaning that while the price of land has a rising trend, the number of farms tends to decrease (Table 4).

Table 4. Determining of the Pearson correlation coefficient between the land price and the number of farms

		Number of Holdings
The price of land	PearsonCorrelation	-.791*
	Sig. (2-tailed)	0.001
	N	9
*Correlation is significant at the 0.05 level (2-tailed).		

Source: own representation in SPSS, 2021.

In Romania, the price of land shows an upward trend due to the tendency to consolidate them and the sector as well as due to the fertility and quality of land in Romania. However, the structure of agricultural land use in the country has not changed significantly in recent times, so there is the same degree of land fragmentation. The number of farms showed a continuous decrease, which clearly indicates the decrease in interest in practicing this type of activity, and the persistence of subsistence and semi-subsistence farming [2]. Therefore, the upward trend of prices correlated with the downward trend of farms highlights the fact that there is a problematic situation faced especially by Romanian agriculture.

From a statistical point of view, the correlation between the dependent variable, the "land price" and the independent variable "single area payment scheme" is not valid, so the significance of the 2-tails test is above the 0.05 threshold (Table 5).

Table 5. Determination of the correlation coefficient between the land price and the single area payment scheme

		Single area payment scheme
The price of land	Pearson Correlation	-.134
	Sig. (2-tailed)	.731
	N	9

Source: own representation in SPSS, 2021.

CONCLUSIONS

Agricultural land prices in Romania are significantly lower than those recorded in Italy, Germany, Poland and even Bulgaria, but have increased in recent years due to the presence of several factors.

The price of one hectare of agricultural land came to be sold in 2019 with an average price of 5,339 euro, a high price for Romania, but much lower compared to the sale prices of land recorded by other EU countries.

However, it is expected that in the next period the same growth trend will be maintained, reaching in 2022 that the price of one hectare of land will be about 9,000 euro.

Rising farmland prices can have a positive impact due to the European Union's financial support for the agricultural sector and agricultural activities.

However, the link between the increase in sales prices of agricultural land and the number of holdings was established, so that the Person correlation coefficient indicated a close, inversely proportional link.

It should be noted and noted the trend of rising land prices at the same time as the decrease in the number of farms that highlights the poor situation in agriculture in Romania.

There is no link between the selling price of agricultural land and the single area payment scheme, as the sigma significance threshold exceeds 0.05.

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PROFIT SENSITIVITY ANALYSIS IN AGRICULTURE BASED ON EFFECTS MEASUREMENT

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Abstract

The article addresses methodological issues aimed at estimating the sensitivity of profit under the influence of changes in yield per hectare and reduction of unit costs. As a result of the calculations, three areas of profit elasticity were delimited: moderate, increased, high. The area of moderate elasticity located in the range of yield of 30-31q/ha is characterized by the increase of yield by one quintal which ensures the highest increase of profit 6.44 lei per unit of product. In the areas of increased elasticity (40-41 q/ha) and high elasticity (50-51 q/ha) the increase of the corn yield contributes to the increase of the respective unit profit by 3.65 and 2.35 lei. The research allowed us to determine the minimum amount of profit. It was found out that in agricultural enterprises the actual amount of profit for wheat and corn is less than the minimum amount, which does not allow the achievement of simple reproduction.

Key words: *agricultural production, effect, profit, profitability threshold*

INTRODUCTION

The pursuit of a profitable business involves the achievement of sufficient profit to cover expenses, debt repayment and technological reinvestment for business development. Like any economic phenomenon, profit can be studied from a dynamic, structural and factorial point of view, so as to ensure the coherent certainty of these aspects of analysis.
The analysis of profit sensitivity to the variation of the costs and of the activity level foresees the application of the profitability threshold method which is also known as “critical point”, “dead point”. This method makes it possible to establish the conditions necessary to achieve microeconomic balance, as it highlights the level of activity at which the company must be located in order not to work at a loss [7].
In this context, the purpose of the paper is the determination of profit elasticity in accordance with agricultural crops yield.

MATERIALS AND METHODS

The profitability threshold and the conditions of microeconomic equilibrium depend on the branch specifics of the analyzed enterprises [5]. In this context, the analysis methodology based on the indicators specific to the branch aspect of the agricultural enterprises allows the estimation of the profit sensitivity under the influence of the yield per hectare and the reduction of the unit cost. The research has shown that fluctuations in profit from the sale of agricultural products depend on changes in the volume of sold products (Q), the average selling price per unit of product (P), unit cost (C), based on the following formula of factorial dependence [2]:

$$B = Q \times (P - C) \qquad (1)$$

According to the formula, we can mention that the company cannot influence the prices of the agricultural products it sells, nor the prices of the materials does it buy (fertilizers, seeds, pesticides, petroleum products, etc.). Therefore, the only variable on which the agricultural enterprise can act is the average production (yield) per hectare, the increase of which can allow increasing the sales volume and reducing the unit cost [1]. In our opinion, the average production per hectare corresponding to the profitability threshold

(q_{min}) must be determined according to the formula [10]:

$$q_{min} = \frac{CFh}{P-CVp} \quad (2)$$

where:
CF_h – constant costs calculated per hectare, lei;
P - average selling price per unit of product;
CV_p - variable costs per unit of product (Lei).
Thus, from formula 2 we can observe that the formative element of the profitability threshold is the division of production costs into variable and constant [6].
Depending on this aspect, we propose the calculation of the cost per unit of agricultural product according to the formula [9]:

$$C = CV_p + \frac{CF_h}{q} \quad (3)$$

where:
q – yield (average productivity) per hectare, quintals.
The information base of the investigation constituted the following selected sources from agricultural enterprises in the Central Region of the Republic of Moldova:
- Annual statistical survey 21-Sale "Sale of agricultural production";
- Register of cost records by types of agricultural products.
It is known that the profit per unit of product expresses the difference between the average selling price (P) and the unit cost (C). Substituting C according to formula 3 we obtain the calculation ratio of the profit to 1q of product (Bp).

$$B_p = P - C = P - (CV_p + \frac{CF_h}{q}) \quad (4)$$

Thus, the profit per hectare of productive area (Bh) will be calculated according to the formula:

$$B_h = q \times (P - CV_p) - CF_h \quad (5)$$

Change in profit per hectare under the influence of yield increase (ΔB_h^q) and the reduction of the unit cost (ΔB_h^c) are traditionally determined by the relationships:

$$\Delta B_h^q = (q_1 - q_0) \times (P_0 - C_0) \quad (6)$$

$$\Delta B_h^c = -(C_1 - C_0) \times q_1 \quad (7)$$

The works of the local scientists D. Parmacli, A. Stratan showed that in order to ensure extended reproduction in agriculture the increase in profit under the influence of increasing yield per hectare must exceed or be equal to the increase in profit under the influence of the unit cost reduction, inequality $\Delta Bq \geq \Delta Bc$ would be preferred [3].
If the profit increases equally under the influence of both factors the expression $\Delta Bq = \Delta Bc$ can be presented:

$$(q_1 - q_0) \times (P_0 - C_0) = -(C_1 - C_0) \times q_1 \quad (8)$$

Substituting the unit cost (C) according to formula 3 we obtain:

$$(q_1 - q_0) \times \left[P_0 - \left(CV_{p(0)} + \frac{CF_h}{q}\ (0)\right)\right] = -\left[\left(CV_{p(1)} + \frac{CF_h}{q}\ (1)\right) - \left(CV_{p(0)} + \frac{CF_h}{q}\ (0)\right)\right] \times q_1 \quad (9)$$

Thus, we can conclude that for a certain level of activity the profit under the influence of the increase of the yield per hectare is equal to its size obtained under the influence of the unit cost reduction [8].
At the same time, we would like to mention that the experience of many agricultural enterprises has shown that only at the expense of improving the technologies of cultivation and harvesting of agricultural crops without additional costs it is possible to increase the yield and profit, respectively.
In this case the change in profit as a result of the increase in yield per hectare (ΔB_p^q) is proposed to be calculated by dividing $B_{p(0)}$ and B_p'.
Thus, we obtain:

$$\Delta B_p^q = B_p' - B_{p(0)} = \left[P_0 - CV_{p(0)} - \frac{CF_{h(0)}}{q'}\right] - \left[P_0 - CV_{p(0)} - \frac{CF_h}{q}\ (0)\right] = CF_h\left(\frac{1}{q_0} - \frac{1}{q'}\right) =$$

$$= \frac{CF_h}{q_0^2 + q'} = \frac{CF_h}{[q_0^2 + (q_0 + 1)]} \quad (10)$$

where:
q' – the yield obtained as a result of the improvement of cultivation technologies or q '= q_0 + 1, which attests to the increase of the yield by one unit compared to the base period;
B'_p – profit obtained as a result of the increase in yield per hectare q '.

RESULTS AND DISCUSSIONS

Based on formula 10 we will calculate the profit increase per 1q of corn as a result of increasing the yield per hectare by 1q if it is known that on average on the totality selected by enterprises the constant costs per hectare constituted 5,997.8 lei.
Thus, at the level of yield 30-31 q/ha, the profit per 1 q will increase by 6.44 lei.

$$\Delta B_p = \frac{5{,}997.8}{30^2 + 30} = +6.44 \text{ lei}$$

At the level of yield 40-41 q/ha, the profit increase will be 3.65 lei.

$$\Delta B_p = \frac{5{,}997.8}{40^2 + 40} = +3.65 \; lei$$

In the case of the yield of 50-51 q / ha, the profit per 1 q will increase by 2.35 lei.

$$\Delta B_p = \frac{5{,}997.8}{50^2 + 50} = +2.35 \; lei$$

Following these calculations, we delimited three areas of profit elasticity per a quintal of corn: moderate, increased, high. The area of moderate elasticity located in the range of yield of 30-31 q/ha is characterized by the fact that the increase of average production per hectare by one quintal (1q) ensures the highest increase in profit by 6.44 lei. In the areas of increased elasticity (40-41 q/ha) and high elasticity (50-51 q/ha) the increase of the yield per 1 q contributes to the increase of the respective unit profit by 3.65 lei and 2.35 lei.
The investigations of the authors Parmacli D. and Tcaci N., demonstrated the multiplicative effect of crop yield on profit change. Simultaneously with the direct influence of yield on profit, its increase also contributes to the reduction of unit cost. These authors identified that the increase in profit due to the reduction of unit cost may outpace the increase in profit obtained from the increase in sales volume and productivity per hectare [4].
In arguing these results we performed the calculations according to the proposed method (formulas 3-7), where we determined the profit increase under the action of increasing the yield - direct effect and reducing the unit cost - complementary effect.
On average for the years 2015-2017 in the studied agricultural enterprises, the cost of 1q of wheat was:

$$C_0 = \frac{1{,}976.83}{34.05} + 118.09 = 176.15 \; lei$$

The increase of the yield by 3.2%, i.e. up to 35.15 q / ha will lead to the decrease of the cost from 176.15 to 174.33 lei:

$$C_1 = \frac{1{,}976{,}83}{35{,}15} + 118{,}09 = 174.33 \; lei$$

The profit calculated per hectare in the basic period and after the increase of the yield will constitute:

Bh(0) = 34.05 (224.35 – 118.09) – 1,976.83 = 1,641.32 lei

Bh(1) = 35.15 (224.35 – 118.09) – 1,976.83 = 1,758.21 lei

Thus, ΔBh = +116.89 lei.

We would like to mention that the increase of the efficiency also contributes to the reduction of the unit cost. This implies the need to know the share of the increase in yield (ΔB^q) and the reduction of the unit cost (ΔB^c) when changing the profit.
Therefore, the increase of yield from 34.05 to 35.15 q will contribute to the increase of profit per hectare by 53.02 lei:

$\Delta B^q = (q_1 - q_0) \times (P_0 - C_0)$ = (35.15 – 34.05)×(224.35 – 176.15) = +53.02 lei.

Due to the reduction of the unit cost from 177.15 lei to 174.33 lei, the profit per hectare increased by 63.87 lei:

$\Delta B^c = q_1 \times [-(C_1 - C_0)]$ = 35.15× [-(174.33 – 176.15)] = +63.87 lei.

From the performed calculations, it results that due to the increase of productivity per hectare, i.e. the direct effect, the profit per hectare increased by 53.02 lei or by 45.4%.

The reduction of the unit cost - of the complementary effect- conditioned the profit increase by 63.87 lei or by 54.6%. These data confirm the results of the investigations of the nominated authors, as well as the fact that the complementary effect occupies a larger share in increasing the profit compared to the direct effect.

In Table 1 we present the contribution of the direct and complementary effects at different levels of yield.

Table 1. Change in profit under the influence of yield and unit cost of wheat production in agricultural enterprises in the Central region on average 2015-2017

Yield, q/ha	Cost 1q, lei	Profit (loss) in calculation:		Profit change, ±				
		per 1 ha, lei	per 1q, lei	In calculation per ha – total, lei	including under the influence of			
					yield increase		unit cost reduction	
					lei/ha	share,%	lei/ha	share,%
5	513.46	-1,445.55	-289.11	-	-	-	-	-
10	315.77	-914.2	-91.42	1,519.8	-457.1	-30.08	+1976.9	+130.08
15	249.88	-382.95	-25.53	860.7	-127.65	-14.83	+988.35	+114.83
20	216.93	+148.4	+7.42	696.1	+37.1	+5.33	+659.0	+94.67
25	197.16	+679.75	+27.19	630.2	+135.95	+21.57	+494.25	+78.43
30	183.98	+1,211.1	+40.37	597.25	+201.85	+33.8	+395.4	+66.2
35	174.57	+1,742.3	+49.78	578.25	+248.9	+43.04	+329.35	+56.96
40	167.51	+2,273.6	+56.84	566.6	+284.2	+50.16	+282.4	+49.84
45	162.02	+2,804.85	+62.33	558.7	+311.65	+55.78	+247.05	+44.22
50	157.63	+3,336.0	+66.72	553.1	+333.6	+60.31	+219.5	+39.69

Source: Authors' calculation.

From the calculations performed in Table 1 we found out that in the range of yield from 5 to 15q/ha the agricultural enterprises bear losses per hectare in the amount of 382.95 - 1,445.55 lei. Wheat production is profitable when the yield per hectare reaches only 20q. Increasing the yield from 25q/ha to 50q/ha, ensures the increase of the profit per hectare more than 3.9 times. But the highest level of profitability is found when the yield is in the range of 40-50 q/ha. At this level, the rate of wheat profitability varies from 33.93% to 42.33%. When wheat production reaches 40q/ha, the equality between the share of direct effect (50.16%) and of the complementary effect (49.84%) occurs. The increase of the yield over 40q / ha leads to the increase of the share of the direct effect (55.78% - 60.31%) in the profit formation.

The data in Fig. 1 state the fact that below the productivity level of 40q/ha the predominant share in profit formation belongs to the complementary effect which varies from 57% to 94.7%. These data confirm that the complementary effect occupies a higher share in the profit increase, which attests that its influence can be much stronger in relation to the direct effect.

The effect structure in profit formation is presented in Figure 1.

From the graphic presentation (Fig. 1) we can deduce that the increase of yield per hectare from 20 to 50q conditions the reduction of the unit cost by 59.3 lei and respectively the reduction of the complementary effect's share in profit formation per 1 hectare by almost 55 percentage points.

Our calculations show that in agricultural enterprises from the Central region of the Republic of Moldova more than 75% of gross profit is obtained from the sale of cereals and sunflower. In this context, it is necessary to determine the amount of the minimum profit calculated per one hectare that allows simple and extended reproduction.

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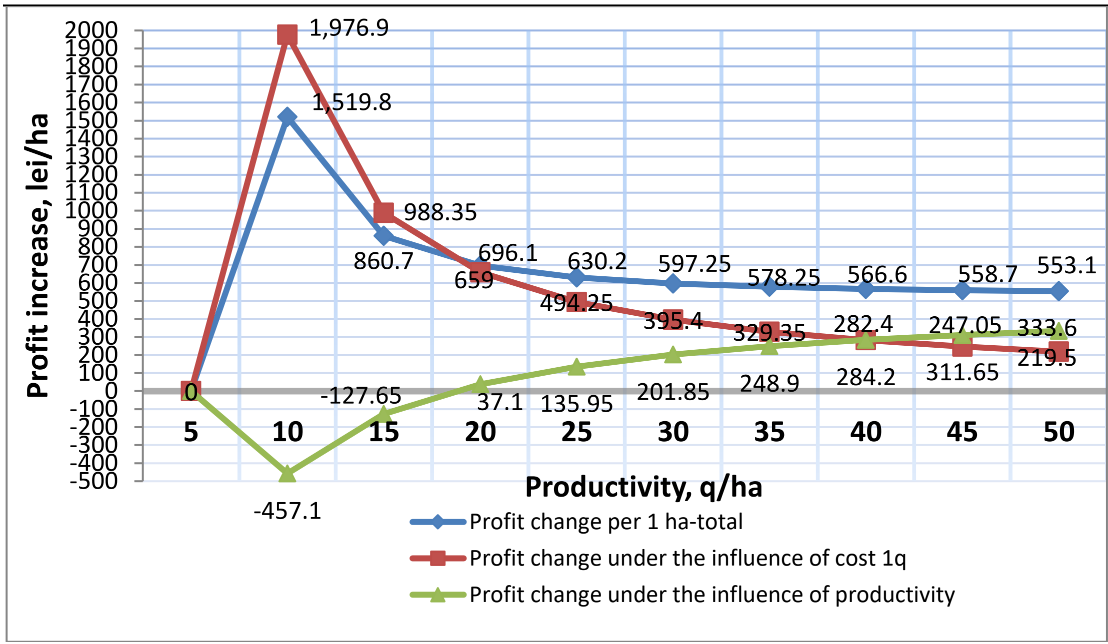

Fig. 1. Profit change per 1 hectare of wheat under the influence of direct and complementary effects on average 2015-2017
Source: Elaborated based on the data from Table 1.

Our investigations have shown that the minimum level of profitability of crop production in order to ensure simple reproduction in agricultural enterprises of the Central region is 19.0–23.0%, and for extended reproduction - 30.0-33.0% [10]. We used these figures as a basis in determining the amount of the minimum profit from the sale of certain products per hectare appling formula:

$$B_{h(min)} = R \times \frac{CP}{S} \quad (11)$$

where:
R - rate of return, coefficient;
CP – production costs;
S – area, ha.

Applying formula 11 we calculated the minimum amount of profit per hectare in the profile of agricultural crops (Table 2).

Table 2. Determination of the minimum profit quantum per hectare of productive area in the profile of agricultural crops in the enterprises of the Centeal region

Crop	**Actual profit, lei/ha**		**The minimum profit quantum calculated per hectare (lei) aiming at the insurance of**				**Financial security reserve in 2016-2017, ±%**	
			simple reproduction		***extended reproduction***			
	on average 2014-2015	***on average 2016-2017***	***on average 2014-2015***	***on average 2016-2017***	***on average 2014-2015***	***on average 2016-2017***	**to ensure simple reproduction**	**to ensure extended reproduction**
Wheat	1,562.04	2,608.46	1,178.5	2,955.5	1,537.15	3,855.0	-13.3	-47.79
Barley	1,058.68	1,374.13	896.7	912.5	1,169.65	1,190.24	+33.6	+13.38
Corn	1,291.77	979.47	1,793.1	1,831.9	2,338.82	2,389.46	-87.03	-143.95
Sunflower	3,516.41	3,726.67	1,395.7	1,600.1	1,820.52	2,087.1	+57.06	+44.00
On average	**2,169.25**	**2,694.09**	**1,335.08**	**2,122.76**	**1,741.41**	**2,768.82**	**+21.21**	**-2.77**

Source: Authors' calculation.

From the calculations made in Table 2 it follows that in the reference periods sufficient profit was obtained for simple and extended reproduction only for barley and sunflower. On the average 2016-2017, the actual amount of profit from the sale of sunflower exceeded the minimum amount by 57.06 and 44.00%. This overrun resulted in sufficient profitability to ensure simple reproduction on average across all crops. In this situation, the minimum amount was exceeded by 21.21%.

At the same time, from the data presented in Table 2 we find out that the actual profit obtained from the sale of wheat and corn is not sufficient even for simple reproduction. On the average 2016-2017, less profit was obtained than the minimum quantum for simple reproduction of wheat by 347.04 lei/ha or by 11.74%. An aggravating situation is found in corn, where the insufficiency of profit for simple reproduction is 87.03%, and extended reproduction - almost 144%. The calculations show us that in order to reach the rate of return of 20-23%, the agricultural enterprises in the Central region must obtain a profit per 1 hectare of area sown with wheat and corn of not less than 2,955.5 lei and 1,831.9 lei respectively. It is obvious that these results can be obtained if agricultural enterprises with their own efforts but also with the support of the state will ensure the increase of yields per hectare.

CONCLUSIONS

The development of the profitable activity in the agricultural enterprises implies the quantification of the profit sensitivity to the variation of the yields per hectare and to the unit costs through the prism of the profitability threshold. The application of this method of analysis allowed the identification of the link between the level of activity, variable costs, constant costs and profit from the sale of agricultural products. Three areas of profit elasticity were delimited: moderate, increased, high. The highest level of the unit profit increase (6.44 lei) is provided by the moderate area with the lowest yield (30-31 q/ha). In the area of high elasticity (50-51 q/ha) the increase of the yield by a quintal contributes to the profit increase only by 2.35 lei or 1.74 times less than in the moderate area. The minimum amount of profit per hectare of productive area was determined. It was found out that the minimum profit amount was exceeded only for barley and sunflower. For wheat and corn, the minimum profit amount has not been reached, which does not allow agricultural enterprises to perform even simple reproduction.

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THE ANALYSIS OF COST STRUCTURE AND THE IMPACT ON THE PROFITABILITY OF AGRICULTURAL PRODUCTS IN THE REPUBLIC OF MOLDOVA

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Abstract

In this paper is being studied the structure of the production cost by calculation items for agricultural products from the enterprises of the Central region of the Republic of Moldova. The influence of the unit cost on the change in the rate of return was quantified. The results of the factorial analysis show that the increase of the unit cost for all agricultural products caused the decrease of the rate of returne: for wheat by 3.89 p.p., for corn by 3.36 p.p., for sunflower by 12.03 p.p. This is partly explained by the fact that in the structure of production costs the items "Fertilizers and "Pesticides" and "Seeds" predominate, which are usually imported at exaggerated prices.

Key words**:** *profitability, production costs, calculation items*

INTRODUCTION

Any economic activity involves human, material and financial resources costs that are recorded according to the principles of organizing financial accounting. The total cost of resources that the company incurs to manufacture the products is the production cost [2].
The analysis of the production cost highlights the way in which the resources (human, material, financial) are used and the impact of their allocation on the profit and profitability [10]. For these reasons, it is necessary to study the cost structure by calculation items in order to optimize or reduce them, where possible, without affecting the normal development of the company's activity [7].

MATERIALS AND METHODS

The information base of the investigation is formed of the following sources selected from 68 agricultural enterprises in the Central Region of the Republic of Moldova:
- Annual statistical survey 21-Sale "Sale of agricultural production";
- Register of cost records by types of agricultural products.

The identification of cost elements that most influence the profitability of agricultural products was performed using the methods specific to economic analysis: comparison [11], division, quota participation method, direct and indirect linkage procedure, regression analysis method [4].
The quantification of the factors influence, including the unit cost when changing the rate of return was performed according to the formula:

$$R_p = \frac{P-C}{C} \times 100\% \qquad (1)$$

Thus, the factors that influence the rate of return of certain products are:
-change in profit per unit of product, which is the difference between the selling price and the unit cost [$\Delta(P-C)$];
-cost change per unit of product (ΔC).
The calculation of the influence of these factors is performed by applying the formulas [8]:

$$\Delta R_P^{\ P-C} = \left(\frac{P_1 - C_1}{C_1} \times 100\%\right) - \left(\frac{P_0 - C_0}{C_1} \times 100\%\right) \qquad (2)$$

$$\Delta R_p^{\ C} = \left(\frac{P_0 - C_0}{C_1}\times 100\%\right) - \left(\frac{P_0 - C_0}{C_0}\times 100\%\right) \qquad (3)$$

Authors proposed to calculate the influence of the items of costs on the change in the rate of return according to formula 4.

$$\Delta R_P{}^{Ci} = \frac{\Delta Ci}{\Delta C} \times \Delta R_P{}^{C} \qquad (4)$$

where: $\Delta R_P{}^{Ci}$ – change in the rate of return under the influence of the calculation item i; ΔCi – modification of the calculation item i.

The linear regression model used to reflect the interdependence between the rate of return and the independent factors had the formula [9]:

$$Y_{1-3} = a_0 + a_1 x_1 + a_2 x_2 \qquad (5)$$

RESULTS AND DISCUSSIONS

The structure of the production cost by calculation items was analyzed in the period 2016 - 2017 for wheat, barley, corn, sunflower and it is presented in Figures 1, 2, 3, and 4.

The study concerning the structure of the production cost based on the Register of cost evidence in the agricultural enterprises from the Central region allowed us to ascertain the following:

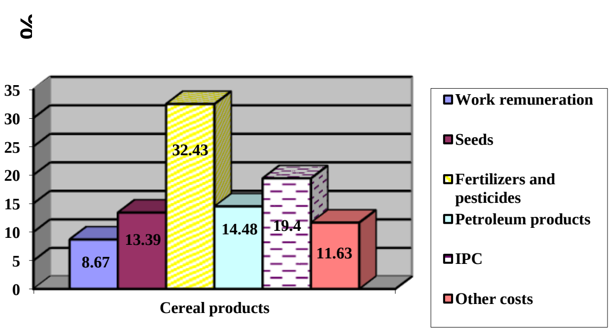

Fig. 1. The structure of the production cost by calculation items for cereal products (including corn) on average for the years 2016-2017
Source: Authors' calculations.

On average for the years 2016-2017, the predominant share belongs to the item "Fertilizers and pesticides", which makes up 32.43% for all cereal products (Figure 1), ranging from 26.27% for barley to 34.93% for wheat (Figure 2), and for corn and sunflower their share is respectively 28.06% (Figure 3) and 32.12% (Figure 4).

The major share belongs to the indirect production costs, which constitute on average for all cereal products 19.4% (Figure 1), for corn - 22.42% (Figure 3) and for sunflower - 17.73% (Figure 4).

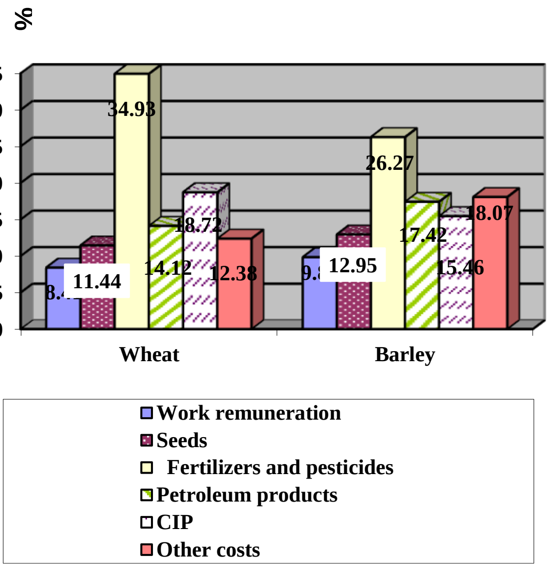

Fig. 2. The structure of the production cost by calculation items for wheat and barley on average for the years 2016-2017
Source: Authors' calculations.

For corn and sunflower, a relatively high share of seed costs in the reference period is 18.3% (Figure 3) and 19.3% (Figure 4).

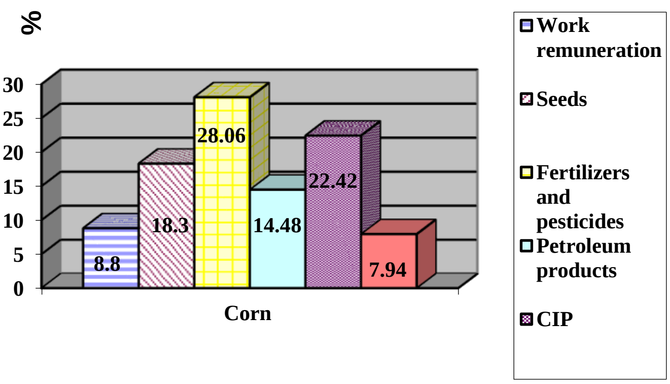

Fig. 3. The structure of the production cost by calculation items for corn on average for the years 2016-2017
Source: Authors' calculations.

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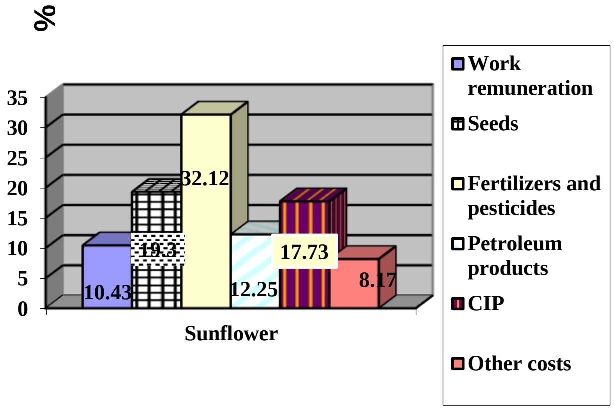

Fig. 4. The structure of the production cost by calculation items for sunflower on average for the years 2016-2017
Source: Authors' calculations.

It explains why some seed material was imported at much higher prices compared to the prices of local seeds.

The costs for the item "Petroleum products" occupy a significant share from 14.12% for wheat to 17.42% for barley (Figure 2), and for sunflower and corn, respectively 12.25% (Figure 4) and 14.48% (Figure 3).

The share of personnel costs is the lowest of all calculation items from 8.41% for wheat (Figure 2) to 10.43% for sunflower (Figure 4), which shows the low level of workers' wages engaged in agriculture.

The analysis of unit cost by types of agricultural products demonstrated increasing trend in the dynamics. Thus, unit cost of corn and of sunflower increased respectively by 41.02 and 81.43 lei (Table 1).

Table 1. Factorial analysis of the rate of return of the main agricultural products in the enterprises of the Central region

Indicator	2014-2015	2016-2017	Calculation of factors influence	The result of the influence ±, p.p.
Wheat				
Factorial 1. Profit calculated by 1q of wheat (B), lei 2. Cost of 1q of product (C), lei	50.85 166.80	38.80 191.14	$\left[\left(\frac{38.8}{191.14}\times100\%\right)-\left(\frac{50.85}{191.14}\times100\%\right)\right]$ $\left[\left(\frac{50.85}{191.14}\times100\%\right)-\left(\frac{50.85}{166.80}\times100\%\right)\right]$	-6.3 -3.89
Resultative Rate of return for wheat R_p, %	30.49	20.30	20.30%-30.49% = -6.3+ (-3.89) -10.19 = -10.19 p.p.	X
Barley				
Factorial 1. Profit calculated by 1q of barley (B), lei 2.Cost of 1q of barley (C), lei	49.61 182.70	67.06 193.62	$\left[\left(\frac{67.06}{193.62}\times100\%\right)-\left(\frac{49.61}{193.62}\times100\%\right)\right]$ $\left[\left(\frac{49.61}{193.62}\times100\%-\left(\frac{49.61}{182.70}\times100\%\right)\right]$	+9.01 -1.53
Resultative 3. Rate of return for barley R_p ,%	27.15	34.63	34.63%-27.15% = 9.01+(-1.53) +7.48 = +7.48 p.p.	X
Corn				
Factorial 1. Profit calculated by 1q of corn (B), lei 2.Cost of 1q of corn (C), lei	26.74 161.38	24.89 202.40	$\left[\left(\frac{24.89}{202.4}\times100\%\right)-\left(\frac{26.74}{202.4}\times100\%\right)\right]$ $\left[\left(\frac{26.74}{202.4}\times100\%\right)-\left(\frac{26.74}{161.38}\times100\%\right)\right]$	-0.91 -3.36
Resultative 3. Rate of return for corn R_p, %	16.57	12.30	12.3%-16.57% = -0.91+ (-3.36) -4.27 = -4.27 p.p.	X
Sunflower				
Factorial 1. Profit calculated by 1q of sunflower seeds (B), lei 2.Cost of 1q of sunflower seeds (C), lei	180.08 310.77	210.09 392.2	$\left[\left(\frac{210.09}{392.2}\times100\%\right)-\left(\frac{180.08}{392.2}\times100\%\right)\right]$ $\left[\left(\frac{180.08}{392.2}\times100\%-\left(\frac{180.08}{310.77}\times100\%\right)\right]$	+7.65 -12.03
Resultative 3. Rate of return for sunflower seeds R_p, %	57.95	53.57	53.57%-57.95% = 7.65+(-12.03) - 4,38 = - 4.38 p.p.	X

Source: Authors' calculations.

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The calculations performed in this Table certified that increament of the unit cost negatively influenced the rate of return of all agricultural products bringing about its diminution.

The results of the factor analysis according to formulas (2) and (3) are presented in Table 1.

According to the calculations presented in Table 1, we can draw the following conclusions:

(i) The decrease in the rate of return of wheat production was determined by the decrease in profit per unit of product compared to the base period by 6.3 percentage points and by the increase in the cost of one quintal of wheat which caused the reduction in profitability by 3.89 percentage points. In the same direction, the factors influenced the decrease of the profitability rate of the corn, only that the decisive action was exercised by the increase of the unit cost by 41.02 lei, which caused the reduction of the profitability by 3.36 percentage points.

(ii) In the production of barley and sunflower seeds, the increase in profit per unit of product had a positive influence, increasing the respective rate of return by 9.01 and 7.65 percentage points respectively. At the same time, the increase of the unit cost for these products had an unfavorable influence causing the decrease of the rate of return by 1.53 and 12.03 percentage points, respectively. On the sunflower production is ascertained a difficult situation, because unit cost influenced decisively and therefore on each leu of production cost profit decreased by 4.38 bani compared to the previous period.

Given that in the period 2016-2017 the unit cost of the main agricultural products had an increasing trend and this fact influenced the considerable decrease of profit and rate of return, we will further quantify the influence of cost in the profile of calculation items when changing the rate of return (Tabel 2).

Table 2. Calculation of costs influence by items when changing the rate of return of agricultural products in the enterprises from the Central region

Cost items	Wheat		Corn		Sunflower	
	Absolute cost deviation 1q, lei	Change in profitability,±p.p.	Absolute cost deviation 1q, lei	Change in profitability, ±p.p.	Absolute cost deviation 1q, lei	Change in profitability, ±p.p.
1. Direct personnel costs (work remuneration)	+1.59	-0.254	+4.46	-0.365	+2.83	-0.419
2. Seeds	+3.92	-0.627	+6.03	-0.494	+19.46	-2.875
3. Fertilizers and pesticides	+11.46	-1.831	+10.17	-0.834	+18.26	-2.697
4. Petroleum products	+4.51	-0.721	+3.54	-0.29	+6.31	-0.932
5. Indirect production costs	+1.99	-0.318	+14.56	-1.192	+33.46	-4.943
6. Other costs	+0.87	-0.139	+2.26	-0.185	+1.11	-0.164
7. Total cost 1q	**+24.34**	**-3.89**	**+41.02**	**-3.36**	**+81.43**	**-12.03**

Source: Authors' calculation.

The calculations made in Table 2 show that the rate of return decreased under the influence of growth of all cost items. However, its impact is different. Thus, for wheat, the increase of the cost of 1q per item of „Fertilizers and pesticides" by 11.46 lei compared to the previous period determined the decrease of profitability by 1.831 percentage points. The increase of the cost of one quintal of wheat on cost items „Petroleum products" and „Seeds" by 4.51 lei and 3.92 lei caused the reduction of the rate of return respectively by 0.721 and 0.627 percentage points.

For corn and sunflower, the main items that influenced the increase of the unit cost and the reduction of the rate of return are: „Indirect production costs", „Fertilizers and pesticides", „Seeds". Thus, the increase of indirect production costs in the calculation of one quintal of corn by 14.56 lei caused the decrease of profitability by 1.192 percentage points.

For sunflower, significant influence is found on the cost item „Indirect production costs" which increment caused growth of the unit cost by 33.46 lei and consequently led to the decrease of the rate of return by 4.943 percentage points.

The increase of the cost of a quintal of corn and sunflower for the item „Fertilizers and pesticides" by 10.17 lei and 18.26 lei respectively caused the decrease of profitability by 0.834 and 2.697 percentage points respectively. The costs for the item of „Seeds" per one quintal of sunflower increased by 19.46 lei, which led to a decrease in the rate of return by 2.875 percentage points. For a more convincing argument of the influence of the unit cost on the change of the rate of return, is recomended the application of the regression analysis method [1], [3], [6], [10].

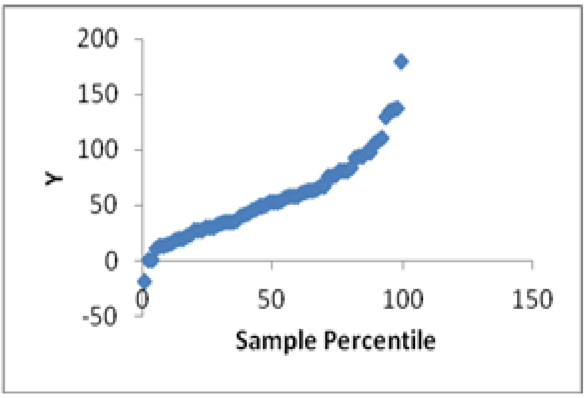

Fig. 5. Normal probability plot
Source: Authors' calculations.

In this context we studied the correlation between the rate of return at product level (y_{1-3}) as a dependent variable and the independent variables: the cost of a quintal of product (x_1), the average selling price of one quintal of product (x_2). Preventively, the connection between the variables that form the structure of the mathematical model of the profitability of wheat, corn, sunflower was studied graphically (Figure 5). The analysis of the graphical representation (Figure 5) allowed us to conclude that in this case the linear regression model can be applied which adequately synthesizes the interdependence between the rate of return with the factors: unit cost of product (x_1); average selling price (x_2) according to formula 3. As a result of the calculations, the following regression equations were obtained (Table 3). The regression coefficients of the equations presented in Table 3 demonstrate the following:

-The increase of the cost of a quintal of product by one leu lead to the decrease of the rate of return for wheat by 1.02 p.p., for corn by 0.99 p.p. and for sunflower by 0.48 p.p.;

-The increase of the selling price of a quintal of product by one leu contributes to the increase of the rate of return for wheat by 0.77 p.p., for corn by 0.78 p.p. and for sunflower by 0.3 p.p.

Tabel 3. Equations of the rate of return regression at product level in agricultural enterprises in the Central region

Products	Regression equation	Multiple correlation coefficient (R)	Coefficient of determination (R^2)
Wheat	$y_1 = 45.65 - 1.023 x_1 + 0.77 x_2$	0.883	0.78
Corn	$y_2 = 51.84 - 0.99 x_1 + 0.775 x_2$	0.827	0.684
Sunflower	$y_3 = 65.04 - 0.475 x_1 + 0.3 x_2$	0.95	0.9

Source: Authors' calculations.

These changes are valid, if other variables remain stable on the same level [3].

Testing the significance of the parameters of the regression equations with the help of the multiple correlation coefficient (R) shows us that there is a strong connection between the variables of the studied system (0.827-0.95). This conclusion is also confirmed by the values of the coefficient of determination (R^2) based on which we can deduce that the rate of return on agricultural products is determined by the factors included in the mathematical model in the proportion of 68.4% -90%.

CONCLUSIONS

The researches showed us that during the reference period the unit cost of main agricultural products in the enterprises of the Central Region of the Republic of Moldova had an increasing trend, which caused a considerable decrease in profit and rate of return. This is partly explained by the fact that in the structure of production costs the articles "Fertilizers and "Pesticides" and "Seeds" predominate, which are usually imported at exaggerated prices. Thus, for sunflower, these articles caused the increase of the unit cost in the respective reference period by 18.26 and 19.46 lei, respectively, and consequently led to the decrease of the rate of return, respectively by 2.7 and 2.88 percentage points. The testing of the parameters of the regression equations shows us that they can be used to estimate the forecast in the conditions of adopting real variants aimed at changing the unit costs and the selling prices for agricultural products [5].

In the context of complex efforts to increase profitability, measures are required to diagnose on the one hand the costs of production, and on the other - the commercial policy of the company with reference to the selling prices of agricultural products. The setting of sale prices must attract as wide a segment of buyers as possible, after which, depending on the evolution of the supply-demand ratio, the entity can choose the most appropriate strategy.

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THE TECHNOLOGICAL ITINERARY, SYSTEM OF MACHINES FOR THE CULTIVATION OF JERUSALEM ARTICHOKE *HELIANTHUS TUBEROSUS* AND ITS USE AS FODDER AND ENERGY BIOMASS

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Abstract

The technological itinerary and the system of machines and equipment used for the cultivation of Jerusalem artichoke, Helianthus tuberosus L., and possibilities to use on the cv. Solar as fodder and energy biomass are presented in this article. We found to planting and harvest Jerusalem artichoke tubers, the same agricultural machinery and equipment will be used as for potatoes crop, and to harvest aerial biomass – agricultural machinery and equipment for harvesting corn and other silage crops. The Jerusalem artichoke energy biomass can be processed into solid fuel with the available briquetting/pelletizing machines, the net calorific value of solid biofuel was 17.7 MJ/kg and the ash content – below 2.2 %. It has been determined that the prepared silage contained 240-290 g/kg DM, 9.7-13.5 % CP, 8.90-12.96 % CA, 55.9-62.3 % NDF, 31.0-45.8 % ADF, 4.8-6.3 % ADL, 11.25-12.43 MJ/kg DE, 9.23-10.21 MJ/kg ME and 5.96-7.02 MJ/kg NEl. The biochemical methane potential of Jerusalem artichoke silage substrate 4,000-6,000 m^3/ha. The lignocellulosic substrate of Jerusalem artichoke dry stems contained 276 g/kg cellulose, 176 g/kg hemicellulose, 98.04 g/kg hexoses sugars and 45.4 g/kg pentoses sugars, the theoretical bioethanol yield from stems was 598 l/kg. Helianthus tuberosus cv. Solar may serve as an alternative crop for producing silage and as a sustainable source of feedstock for renewable energy production.

Key words: *biochemical composition, biomethane potential, Helianthus tuberosus cv. Solar, physical and mechanical properties, silage fodder value*

INTRODUCTION

Recently, the value of some neglected and underutilized plant species has been reassessed and researchers concluded that they can be successfully cultivated for different purposes.

Jerusalem artichoke, *Helianthus tuberosus* L. (synonym *H. esculentus* Warsz., *H. serotinus* Tausch, *H. tomentosus* Michx), fam. Asteraceae, native to North America, is a C_4, herbaceous, perennial plant. The stem is erect, cylindrical, woody at the base, slightly furrowed longitudinally, stiff-hairy, green with anthocyanin shades, covered with a layer of bluish-gray wax, 1.5–5.0 m tall, branched at the top, with 50–70 leaves. The leaves are dark green, on the lower part of the stem – opposite, and at the top – alternate; they are petiolate with a medium-sized ovate leaf blade, with a roughly toothed margin. The inflorescences are solitary flower heads produced at the top of the branches, of 4–6 cm in diameter when fully open. The flowering stage starts at the end of August-September. The involucral bracts are imbricate, ovate-lanceolate, acute to acuminate, and with stiff hairs on margins. The ray florets are ligulate, 3-4 cm long, sterile, with a yellow petal. The disc florets are tubular, hermaphrodite, consisting of a yellowish-white calyx and a yellow gamopetalous corolla with 5 teeth. The androecium consists of 5 stamens with fused anthers, and the gynoecium has a unilocular inner ovary and a style ending in a bifid stigma. Jerusalem artichoke bears fruit depending on the weather conditions. The fruit is an achene, 5–6 mm long and 1.8–2.1

mm wide, light gray. The weight of 1,000 fruits is 5.3–6.4 g. In the underground part of the stem, at the end of May, the development of stolons starts and by thickening their terminal part; tubers of different shape, colour, size and weight are produced. On the surface of the tuber, ring-shaped nodes of the stolon are noticeable. On each ring, two opposite buds develop and then give rise to new plants. The weight of medium-sized tubers is 43–65 g. Jerusalem artichoke is a frost-tolerant species, the tubers in the soil can overwinter under a layer of snow at temperatures as low as -30°C. In spring, the plants resume growth at a soil temperature of 7-10°C, an intensive growth is observed in spring at air temperatures of 18-26°C. Young plants can be affected by spring frosts of -5°C. In summer, they can withstand temperatures above 35°C. Jerusalem artichoke is a mesoxerophilic plant, on one hand, due to the vigorous and deep root system, and on the other hand, due to the fact that during the growing season it covers the soil well. It prefers meadow soil, which is sandy-clayey, loose and rich in humus and calcium. It tolerates less clayey and swampy soils. It propagates by tubers [38].

Jerusalem artichoke, *Helianthus tuberosus* contains large amounts of organic polyacids, including citric acid, malic acid, succinic acid and fumaric acid. Together with vitamin C, these substances can act as antioxidants. Jerusalem artichoke also contains high amounts of pectin (about 11% of dry matter). Pectins are high molecular weight carbohydrates contained mostly in the cell membrane and intercellular tissue of some plants. Pectins possess absorbent, astringent and thickening properties. They may offer several potential health benefits, such as: lowering the cholesterol level, improving metabolic processes, normalizing bowel movements and improving the peripheral circulation. The tubers of Jerusalem artichoke are used for the preparation of salads, including for the prevention and correction of blood sugar in diabetes mellitus; green mass is used in folk medicine, for example, for the prevention of joint diseases (arthrosis, bursitis, arthritis, etc.), as well as herbal baths to relieve fatigue, increase immunity and improve the overall health in the winter-spring period. Currently, this species is researched in various universities and research centres. More than 200 Jerusalem artichoke cultivars have been created and patented worldwide, the cultivated area exceeds 2.5 million ha, tubers are used in food, medicine, biorefineries, and the aerial biomass – as fodder, raw material for obtaining renewable energy, biochemicals and building materials [1, 9, 11, 14, 16, 17, 18, 19, 21, 23, 26, 27, 33, 34, 35, 36, 37, 39, 40, 41, 43, 44]. The Jerusalem artichoke tubers are composed of 72.09-78.23 % water, 17.10-19.47 % carbohydrates, inclusive 12.08 -13.39 % inulin, 10.56-13.49 mg/100g fresh mass vitamin C and 1-2 % protein [7]. Jerusalem artichoke tuber flour has a high content of essential amino acids such as histidine, isoleucine, methionine, phenylalanine and valine, the replacement of wheat flour with 5% Jerusalem artichoke tuber flour, to obtain a product rich in micro and macronutrients with better organoleptic properties and a longer shelf life, which positively influences human health [5].

In the Catalogue of Plant Cultivars of the Republic of Moldova, there are 3 registered cultivars of Jerusalem artichoke: ‘Solar’, ‘AMIC 1’ and ‘AMIC 2’ [4].

While conducting this research, we aimed at identifying the most optimal techniques and equipment for the cultivation of Jerusalem artichoke, *Helianthus tuberosus* L., to make it possible to use its biomass as a source of fodder and fuel.

MATERIALS AND METHODS

The cultivar ‘Solar’ of Jerusalem artichoke *Helianthus tuberosus* L. was created in the National Botanical Garden (Institute) and registered in 2014 in the Catalogue of Plant Varieties [4] and patented in 2016, by the State Agency on Intellectual Property (AGEPI) of the Republic of Moldova, patent no. 209/31.05.2016 [3]. The plants that have been cultivated in the experimental plot of the “Alexandru Ciubotaru” National Botanical Garden (Institute), Chişinău, served as research subjects.

The technological itinerary was elaborated on the basis of the analysis of the specialized literature, and the technical means necessary for its realization were determined on the basis of the bibliographic sources and the range agricultural machines and equipment available on the market [1, 2, 12, 17, 19, 20, 21, 25, 28, 29, 30, 31, 40, 42, 47]. Scientific research was also carried out in the Agricultural Machinery Laboratory of the Faculty of Agricultural Engineering and Auto Transport, State Agrarian University of Moldova.

Fresh mass samples were taken for evaluation at the beginning of the flowering stage. Whole plants were cut to pieces with the stationary feed shredder, and the fractional composition of the obtained shredded mass was determined by using the vibratory sieve shaker (sieve diameter – 400 mm; opening diameter – 31.5 mm, 16 mm, 8 mm, 3.15 mm). The silage was prepared from shredded mass by compaction in airtight containers. The silage produced by this method was dehydrated in a forced ventilation oven, at 60 °C, for further chemical analyses. After that, we used a laboratory ball mill to grind finely the biological material. The amounts of crude protein (CP), neutral detergent fibre (NDF), acid detergent fibre (ADF), acid detergent lignin (ADL) and crude ash (CA) were determined by near infrared spectroscopy (NIRS) in a PERTEN DA 7200 NIR analysis system, at the Research-Development Institute for Grasslands Brasov, Romania. We applied standard equations to calculate the concentration of hemicellulose (HC) and cellulose (Cel), as well as metabolizable energy (ME), digestible energy (DE) and net energy for lactation (NEl). The estimation of the biogas production potential and the specific methane yield was based on the chemical compounds identified in the cell walls, sulphur-containing lignin and hemicellulose [6]. The dried stalks of *H. tuberosus* were harvested in January and shredded, then, the obtained mass was ground in a hammer mill (diameter of sieve openings: 10 mm and 6 mm). The fractional composition of the shredded and ground mass was determined using the vibratory sieve shaker (sieve diameter of 200 mm and different size of openings). The Jerusalem artichoke pellets and briquettes were manufactured and evaluated using the equipment of the “Solid Biofuels” Laboratory of the State Agrarian University of Moldova and the State Enterprise "Mecagro" Institute of Agricultural Technology.

The estimation of the theoretical potential of bioethanol production (TEP) from Jerusalem artichoke stems (L/kg) was performed according to the equations of the National Energy Research Laboratory (NREL) (Golden, CO) adjusted by Goff et al. [8], as presented below.

$$TEP = [H + P] \times 4.17 \quad (1)$$

where:

$$H = [\%\ Cel + (\%\ HC \times 0.07)] \times 172.82 \quad (2)$$

where:
H - hexose sugars (H)
Cel- cellulose content
HC- hemicellulose content

$$P = [\%\ HC \times 0.93] \times 176.87 \quad (3)$$

where:
P - pentose sugars
HC- hemicellulose content.

The equation indicated above shows that cellulose (Cel) and hemicellulose (HC) are converted into hexoses (H) and pentoses (P).

The amount of cellulose was estimated via subtraction of the values obtained for ADL from the concentration of ADF. The amounts of hemicelluloses were estimated via subtraction of the ADF from the NDF values obtained for each sample.

RESULTS AND DISCUSSIONS

According to the classical agricultural technologies, Jerusalem artichoke should be grown outside the crop rotation system. It can be grown on a land previously cultivated with wheat, corn, sorghum, vetch, peas or soya; but the lands on which sunflower and rapeseed have been cultivated should be avoided because of their common diseases (*Sclerotinia sclerotiorum*). The soil preparation and cultivation techniques are similar to those required by the potato cultivation technology. It is necessary to plough the soil at 25-30 cm depth, to incorporate manure, mineral fertilizers and to loosen the soil. Thus, proper conditions will be created for the development of the root system and the storage of needed water reserves. The soil shall be harrowed several times until autumn and twice in spring, with the disc harrow or the cultivator, to loosen it before planting. The optimal depth for planting the tubers is 4-10 cm, and the distance between rows should be 70 cm. The recommended plant density is 25-40 thousand plants/ha. Weed must be removed when necessary throughout the growing season. The growing season ends with the harvest of the aerial biomass and tubers. Several specialists have mentioned that when creating industrial plantations of Jerusalem artichoke to produce tubers for food, pharmaceutical and biochemical needs, the planting scheme needs to be adjusted to fit the equipment that is going to be used for harvesting and transporting aerial biomass, so that it will not cause any significant soil compaction or tuber damage. The technological elements and the necessary agricultural machinery for the cultivation of *Helianthus tuberosus* were studied by many researchers, such as Kosaric et al. [15], Barloy [2], Soltner [28], Zimin [47], Abdel Maksoud et al. [1], Kalinin [12], Manokhina [19, 20], Starovoytov et al., [29, 30, 31], Mikheev et al. [21], Rossini et al. [26], Liava et al. [17]. Thus, Zimin [47] mentioned that the most difficult and time-consuming technological operation is the harvesting of tubers. He concluded that potato harvesters, weighing more than 7 tons, are not suitable for the conventional technology, because 45% of the tubers are thrown away in the field along with the roots, and recommended using the digger-loader KP-2, weighing 1,800 kg, designed by VISKHOM to re-equip the machine KCT-1.4. Romanyuk et al. [25] proposed the planting scheme 132x35 + 35 + 35x30 cm; they recommended the feed harvesting combine KBK 8060 "PALESSE FS 8060" for harvesting the aerial biomass, and for transporting it – the PS-60 semi-trailer attached to a BELARUS 1221 tractor. Vlăduţ et al. [42] presented 12 types of machines to harvest Jerusalem artichoke aerial biomass and tubers in small, medium and large areas.

Particle size distribution of chopped green mass influenced the costs of transport and particle size reduction has been reported as one of the major effects of silage quality. It was established that when passing through the feed shredder, the harvested whole plants contained 38-43 % leaf, a moderate amount of humidity and fine fibres, which affected the homogeneity of the shredded mass. It was determined that the Jerusalem artichoke shredded green mass contained 16.0 % particles larger than 16.0 mm, 38.6 % particles of 8.0-16.0 mm, 43.0 % particles of 3.15-8.0 mm and 11.9 % particles smaller than 3.15 mm.

When the containers with silage from Jerusalem artichoke were opened, there was no gas and liquid leakage, the colour of the silage was dark green and it had a specific aroma of pickled vegetables, with active acidity pH = 3.9-4.30 (Photo. 1).

Photo 1. Jerusalem artichoke ‘Solar’ silage
Source: Own photo.

The silage prepared from Jerusalem artichoke ‘Solar’ shredded mass contained 240-290 g/kg dry matter. The biochemical composition and fodder value of silage dry matter were 4.5-5.7 % lactic acid, 1.2-1.4 % acetic acid, 9.7-13.5 % CP, 8.90-12.96 % ash, 4.7-6.5 g/kg Ca and 2.8-3.1 g/kg P, 55.9-62.3 % NDF, 31.0-45.8 % ADF, 4.8-6.3 % ADL, 11.25-

12.43 MJ/kg DE, 9.23-10.21 MJ/kg ME and 5.96-7.02 MJ/kg NEl. The esteemed biochemical methane potential of Jerusalem artichoke silage substrates was 4,000-6,000 m^3/ha. According to Karsli et al. [13] the quality indices of Jerusalem artichoke silage were: pH=4.54-4.81, 2.12-4.30% lactic acid, 2.12-4.30% acetic acid, 0.29-0.41% propionic acid, 0.82-1.14% ammonia-N levels, 29.99-33.28% DM, 85.41-85.79% OM, 8.58-9.59% CP, 35.58-42.53% NDF, 23.94-30.12% ADF, 51.71-54.67% IOMD, 1.87-2.012 Mcal/kg ME. Wang et al. [44] reported that Jerusalem artichoke silage contained 258 g/kg DM, 12.4 % CP, 1.6% EE, 31.7 % ADF, 43.9 % NDF, 7.5% ADL, 11.9 MJ/kg DE, 9.20 MJ/kg ME. Herrmann et al. [10] studied the nutrient and fibre composition of crop silages in Germany and remarked that the Jerusalem artichoke silage contained 14.3-41.3% dry matter and 87.2-92.2% organic matter, pH 3.6-4.3, 5.1-9.6% lactic acid, 0.4-2.1% acetic acid, 4.6-15.0% protein, 0.9-3.3% fat, 37.6-49.9% NDF, 34.7-45.8% ADF, 8.3-17.7% ADL, C/N=18-57, biochemical methane potential 198.9-236.1 L/kg OM. Zhang et al. [46] analysing literature data reported the BMP yields of Jerusalem artichoke substrates varied from 252 to 370 l/kg VS.

In autumn, when temperatures below 0°C are recorded, the rates of dehydration and defoliation of the stems accelerate, and in January, the stems are completely defoliated, and the moisture content does not exceed 15%. It was determined that the shredded mass of dried Jerusalem artichoke stems contained 15.7% particles larger than 8.0 mm, 65.4 % particles of 3.15-8.0 mm, 15.1 % particles of 1.00-3.15 mm and 4.3 % smaller than 1.00 mm. Among the fundamental physical properties of solid biofuel (briquettes, pellets) which were observed belong the density, durability, moisture content and calorific value. It was found that the ground Jerusalem artichoke biomass had a bulk density of 165-190 kg/m^3, and the briquettes had a bulk density of 435 kg/m^3 and a specific density of 872 kg/m^3; the pellets had a bulk density of 552 kg/m^3 and a specific density of 880 kg/m^3 (Photo 2). The net calorific value of solid biofuels was 17.7 MJ/kg and the ash content – below 2.2 %.

There are different results reported in research studies conducted by other authors. In Poland, Kowalczyk-Jusko et al. [16] stated that the calorific value of biomass of the examined varieties of Jerusalem artichoke varied within narrow limits 16.10- 16.30 MJ/kg, while the ash content was 5.4- 5.6%; Stolarski et al. [32] mentioned that the ash content of *Helianthus tuberosus* stalks, from November to April, decreased from 5.26% to 3.02%, but the gross calorific value grew insignificantly from 18.45 to 18.59 MJ/kg dry matter. Urbanovičová et al. [41] mentioned that produced Jerusalem artichoke briquettes contained 11% water, 3.40% ashes, 3.07 g/kg nitrogen, 0.70 g/kg phosphorus, 1.93 g/kg potassium, 0.71 g/kg sulfur, 0.71 g/kg chlorine, 14.41 g/kg lignin, reached density 940 kg/m^3, 92 % durability and 16 MJ/kg calorific value. Zapalowska & Bashutska [45] noted that Jerusalem artichoke pellets were characterized by 6.81% moisture content, 2.04% ash content, 18.85 MJ/kg energy value and 1,024.57 Newton resistance to crushing.

Bioethanol fuel is a renewable energy source, which is a potential alternative to some fossil fuels. Bioethanol is mainly produced by sugar fermentation. The potential of second generation bioethanol produced from lignocellulosic biomass as an alternative energy source has been studied in many research centres around the world. Lignocellulosic biomass contains primarily polymeric sugars, such as cellulose and hemicellulose, lignin and minerals, in smaller amounts (ash). The amounts of these components vary significantly depending on the plant species, type of biomass and harvesting time. [9, 17, 18, 22, 24, 26, 43].

Analyzing the cell wall composition, we could mention that the lignocellulosic substrate of Jerusalem artichoke stems (Photo 3) contained 276 g/kg cellulose, 176 g/kg hemicellulose, 98.04 g/kg hexoses and 45.4 g/kg pentoses, the theoretical bioethanol yield from stems was 598 l/kg, for comparison, 556 l/kg can be obtained from corn stems.


A


B

Photo 2. Solid biofuel from Jerusalem artichoke 'Solar'
A – briquettes; B – pellets
Source: Own photo.

Photo 3. Lignocellulosic biomass substrate of Jerusalem artichoke 'Solar' for bioethanol fuel
Source: Own photo.

Several literature sources describe the biochemical composition of Jerusalem artichoke stem. Gunnarsson et al. [9] determined the Jerusalem artichoke stem harvested in December contained 16.5-29.5% cellulose, 9.3-14.6 % hemicellulose, 16.3-20.7% lignin and 1.1-2.9 % protein, 2.1-3.8 % lipids, 10.1-12.7 % extractives and 2.9-7.9 % ash. Prusov et al. [23] remarked that cellulose yield from the stem was: cortex 51.1%, pith 65.2% with the α-cellulose content 96–98%. Wang et al. [43] reported that Jerusalem artichoke stalks contained 320 g/kg lignin, 405 g/kg cellulose, 19.6 g/kg hemicellulose, after NaOH pretreatment the lignin content decreased by 13.1%-13.4%, hemicellulose content decreased by 87.8%-96.9% and cellulose content increased by 56.5%-60.2%.

Liu et al. [18] found that cellulose content of Jerusalem artichoke stem range from 23.3% to 33.4%, hemicellulose content - from 5.9% to 15.1% and lignin from 4.7 to 12% respectively.

The ethanol potential yield from cellulose and hemicellulose in aboveground biomass were 1,821 to 5,930 L/ha, contributing 29.8-66.4% of the total ethanol yield.

CONCLUSIONS

The technological itinerary for cultivating Jerusalem artichoke plants includes soil preparation, weed and pest control during the growing season, aerial mass harvesting, tuber harvesting and storage.

To planting and harvest Jerusalem artichoke tubers, the same agricultural machinery and equipment will be used as for potatoes crop, and to harvest aerial biomass – agricultural machinery and equipment for harvesting corn and other silage crops.

The Jerusalem artichoke energy biomass can be processed in solid fuel with the available briquetting/pelletizing machines.

The prepared silage had pH index 3.90-4.30 and contained 240-290 g/kg DM, 4.5-5.7 % lactic acid, 1.2-1.4 % acetic acid, 9.7-13.5 % CP, 8.90-12.96 % CA, 4.7-6.5 g/kg Ca and 2.8-3.1 g/kg P, 55.9-62.3 % NDF, 31.0-45.8 % ADF, 4.8-6.3 % ADL, 11.25-12.43 MJ/kg DE, 9.23-10.21 MJ/kg ME and 5.96-7.02 MJ/kg NEl. These characteristics indicate a good quality of feed for ruminants.

The biochemical methane potential of Jerusalem artichoke silage substrates was 4,000-6,000 m^3/ha.

The lignocellulosic substrate of Jerusalem artichoke dry stems contained 276 g/kg cellulose, 176 g/kg hemicellulose, 98.04 g/kg hexoses sugars and 45.4 g/kg pentoses sugars, the theoretical bioethanol yield from stems was 598 l/kg.

Helianthus tuberosus cv. Solar may serve as alternative silage crops and sustainable feedstock for renewable energy production.

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SOME AGROBIOLOGICAL PECULIARITIES AND POTENTIAL USES OF *GLYCYRRHIZA GLABRA L.* AND *ONOBRYCHIS ARENARIA* (KIT.) DC. IN THE REPUBLIC OF MOLDOVA

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Abstract

The agrobiological features, the quality of the green mass and haylage from the local ecotype of Glycyrrhiza glabra and Onobrychis arenaria have been the subject of a recent study. It has been found that the dry matter of harvested green mass of the studied crops contained 162-167 g/kg CP, 302-307 g/kg CF, 88-100g/kg CA, 467-471 g/kg NDF, 317-321 g/kg ADF, 48-54 g/kg ADL, 267-269 g/kg Cel, 150 g/kg HC, 100-103 g/kg TSS, 64.7-67.7 % DDM, 54.3-59.9 % ODM, RFV= 125-127, 10.23-10.28 MJ/kg ME and 6.34-6.56 MJ/kg NEl. The biochemical composition of the dry matter of the haylage and its nutritive value: 155-184 g/kg CP, 267-301 g/kg CF, 114-123 g/kg CA, 429-550 g/kg NDF, 299.333 g/kg ADF, 47-50 g/kg ADL, 249-288 g/kg Cel, 130-187 g/kg HC, 79-91 g/kg TSS, 62.4-67.8 % DDM, 53.6-54.0 % ODM, RFV= 113-142, 10.20-10.57 MJ/kg ME and 6.20-6.59 MJ/kg Nel. We found that the studied substrates for anaerobic digestion have C/N=16.54-19.85, optimal amount of lignin and hemicelluloses, the biochemical methane potential varied from 283 to 301 l/kg ODM. The studied ecotype had optimal quality as fodder for livestock and as substrate for biomethane production.

Key words: *biochemical composition, biochemical methane potential, Glycyrrhiza glabra, haylage, nutritive value, Onobrychis arenaria*

INTRODUCTION

Expanding the range of cultivated plants is essential for a sustainable fodder production, which is a key factor for the welfare and achieving the full productive potential of different species and breeds of animals. Besides, such plant species can also be a source of biomass used as raw material for various industries. Perennial legume species provide high quality, energy-protein nutrients as forage for grazing, freshly mowed or as preserved fodder and, at the same time, due to their ability to fix atmospheric nitrogen and mobilize phosphorus in the soil, can contribute to maintaining soil fertility. Under the conditions of an arid climate and intensification of soil salinization processes, the plants of the family *Fabaceae* Lindl (syn. *Leguminosae* Juss.), the genera *Glycyrrhiza* L. and *Onobrychis* Adans. show high tolerance and stable productivity and can more rationally use soil and water resources.

Liquorice – *Glycyrrhiza glabra L.* (sin. *G. glandulifera* Waldst. & Kit., *G. hirsuta* Pall., *G. pallida* Boiss. & Noe., *G. violacea* Boiss. & Noe., *Liquiritia officinarum* Medik.) is a herbaceous, perennial plant, native to southern Europe and the Middle East, also found in the local wild flora of the Republic of Moldova. The stems are erect or ascending, covered with glandular spines, vigorous, branched in the upper part, with 5-25 branches, having a shrub-like appearance, 125-205 cm tall, rough to the touch. The leaves are pale green, whitish on the underside, 5-20 cm long, with short hairy pedicel, imparipinnate compound, with 5-9 pairs of ovate or wide-elliptic leaflets, with numerous glands that secrete a sticky liquid. The stipules are small, lanceolate, and fall during the flowering period. The leaves are similar to acacia leaves. The flowers grow from the axil of the leaves, are bisexual, 8-10 mm long, blue, purple or lilac, with short pedicel, grouped by 50-80 in elongated racemes. Liquorice blooms in June and the fruits ripen in July-August. It is a honey plant with a potential of 50-100 kg/ha honey. The fruits are brown, erect pods covered with hairs, flat, 1.5–2.5 cm long and 4-6 mm wide, with 3-5 seeds – 2-3 mm long and 3-4 mm wide, with a very hard coat, slightly glossy, greyish-green or brown. The weight of 1,000 seeds is 2-3 g. Seed viability: 3-4 years. In the soil, the plant develops a strong tap root system, which reaches a depth of 1.5-2.0 m, often down to 7 m. It produces a thick, spindle-shaped main rhizome, from which grow cylindrical stolons, brown on the outside, yellow on the inside, 1-2 m long, from which many roots and new shoots grow [22].

Sand sainfoin, *Onobrychis arenaria* (Kit.) DC. (sin. *O. borysthenica* (Sirj.) Klokov, *O. brachypus* Vassilcz. Klokov *O. tanaitica* Spreng., *Hedysarum arenarium* Kit.) is a species occurring in the spontaneous flora of different areas of Eurasia, it is often found in the forest-steppe and steppe areas of our region. It was first cultivated in late 19th century in Ukraine from local wild populations. A considerable part of the globally cultivated varieties of sainfoin were created by crossing with *Onobrychis arenaria* species. It is a perennial plant, with erect, whitish stems, with 7-8 internodes, glabrous or slightly pubescenct, 40-90 cm tall and 3-5 mm in diameter at the base. It has pinnate leaves, with 6-15 pairs of elliptical or linear-lanceolate leaflets. The leaflets are 10-30 mm long and 2-5 mm wide, deep green or greenish-gray. The stipules are free, brown, with ciliated edges. The inflorescences are spiciform or fusiform racemes, 5-9 cm long, slightly narrower at the tip. The flowers have 2.5-3.2 mm long bracts, hairy, 2 mm long peduncle, the calyx is 4.3-5.1 mm long, and the bright pink or reddish pink corolla – 8-10 mm the banner is equal or sometimes shorter than the keel, the wings reach 1.9-2.6 mm. *O. arenaria* blooms in May-June. Allogamous pollination is characteristic of this species. Its honey potential is 90-140 kg/ha honey. The plants bear fruits in July. The fruit is a pod longer than calyx, rarely equal to it, semicircular, with a well-defined net-shaped nervation along the disc and along the suture, with short, brown or gray-green teeth, monosperm, indehiscent. The weight of 1,000 fruits is 15-20 g. The seeds are kidney-shaped, brown-green or yellow-gray, slightly shiny. The weight of 1,000 seeds is 9-11 g. The plant has a taproot, growing very deep into the soil, down to 10 m, it also develops oblique or vertical rhizomes, the adventitious roots grow mostly at a depth of 50-100 cm. The roots have a large number of nodules with the bacterium *Rhizobium simplex*, very resistant to high temperatures and long-term drought, the ability to fix atmospheric nitrogen is 200-300 kg/ha annually. Root secretions have a strong ability to dissolve carbonates and phosphates [22].

The goal of this research was to evaluate the agrobiological peculiarities, the quality of the fresh mass and the haylage of *Glycyrrhiza glabra* – licorice and *Onobrychis arenaria* – sand sainfoin.

MATERIALS AND METHODS

The local ecotypes of liquorice – *Glycyrrhiza glabra* and sand sainfoin – *Onobriychis arenaria* grown on an experimental plot in the "Alexandru Ciubotaru" National Botanical Garden (Institute), Chişinău, served as research subjects. *Onobriychis arenaria* was harvested in the flowering stage and *Glycyrrhiza glabra* – in the budding stage. The fresh mass yield, the leaf content and the dry matter were assessed. The haylage was produced from wilted green mass, cut into small pieces and compressed in glass containers. The containers were stored for 45 days, and after that, they were opened and the organoleptic assessment and the determination of the biochemical composition of the haylage were done in accordance with the Moldavian standard SM 108 [19]. The fresh mass and haylage samples were dehydrated in an oven with forced ventilation at a temperature of 60°C. At the end of the fixation, the biological material was finely ground in a laboratory ball mill. The quality of the biomass was evaluated by analysing such indices as: crude protein (CP), crude ash (CA), total soluble sugars (TSS), acid detergent lignin (ADL), neutral detergent fibre (NDF), acid detergent fibre (ADF), digestible dry matter (DDM) and organic digestible matter (ODM), which were determined by near infrared spectroscopy (NIRS) using the PERTEN DA 7200 NIR analysis system, according to standard methods. The analyses were done at the Research-Development Institute for Grasslands Brasov, Romania. Other indices, such as the concentration of cellulose (Cel) and hemicellulose (HC), the digestible energy (DE), the metabolizable energy (ME), the relative feed value (RFV) and the net energy for lactation (NEl) were calculated using standard equations. The carbon content in the organic matter was determined according to the method mentioned by Badger et al. [5], and the biomethane production potential – according to Dandikas et al. [7].

RESULTS AND DISCUSSIONS

At the time of harvesting, the local ecotype of *Onobrychis arenaria* reached 96 cm in height, it yielded 39.5 t/ha fresh mass (6.56 t/ha dry matter), which contained 64.8% leaves and inflorescences. *Glycyrrhiza glabra* plants developed slower, reaching on average 140 cm at the beginning of June. The yield was 33.7 t/ha fresh mass (9.67 t/ha dry matter), with a leaf content of 58.4%. According to Matolinets [15], the productivity of *Onobrychis arenaria*, in the second year of vegetation, was 4.83-5.92 t/ha dry matter. Astafiev et al. [4] mentioned that *Glycyrrhiza glabra* yielded 19.7-22.0 t/ha in lands without irrigation and 55 t/ha in lands with irrigation, and *Glycyrrhiza echinata* yielded 23.4-25.3 t/ha and 58 t/ha, respectively. Hetman & Veklenko [12] mentioned a sand sainfoin yield of 45.9-49.6 t/ha fresh mass, in Ukraine.

At the time when the containers with *Onobrychis arenaria* haylage were opened, it was found that the conserved mass had maintained consistency, the leaves were dark green and the fragments of stems – light olive, with a pleasant smell and aroma of vegetables and pickled fruits. The *Glycyrrhiza glabra* haylage consisted of fragments of yellow stems with green leaves, with pleasant aroma of caramelized fruits.

The results of the assessment of the biochemical composition and nutritional value of fresh and conserved fodder are presented in Table 1. It was found that the natural sand sainfoin feed contained a higher amount of crude protein and a low amount of lignin, which are indicators of a high nutritional value, as well as metabolizable energy and net energy for lactation. In the process of producing haylage from *Glycyrrhiza glabra* plants, we detected an increase in the content of crude protein and ash, and a decrease in the content of cellulose, hemicellulose, lignin and soluble sugars. On the other hand, in *Onobrychis arenaria* haylage, there was a reduction in the crude protein content, but the cellulose and hemicellulose contents increased significantly. This fact affected negatively the digestibility, energy supply and relative feed value.

Table 1. The biochemical composition and nutritional value of fresh mass and haylage from *Glycyrrhiza glabra* and *Onobrychis arenaria*

Indices	*Glycyrrhiza glabra*		*Onobrychis arenaria*	
	fresh mass	haylage	fresh mass	haylage
Crude protein (CP), g/kg	162	184	167	155
Crude fibre (CF), g/kg	307	267	302	301
Acid detergent fibre (ADF), g/kg	321	299	317	333
Neutral detergent fibre (NDF), g/kg	471	429	467	520
Acid detergent lignin (ADL), g/kg	54	50	48	47
Cellulose (Cel), g/kg	267	249	269	286
Hemicellulose (HC), g/kg	150	130	150	187
Total soluble sugars (TSS), g/kg	103	79	100	96
Crude ash (CA), g/kg	100	123	88	114
Digestible dry matter (DDM), %	64.7	67.4	67.7	62.4
Organic digestible matter (ODM), %	54.3	53.6	59.1	54.0
Digestible energy (DE), MJ/kg	12.46	12.87	12.52	12.42
Metabolizable energy (ME), MJ/kg	10.23	10.57	10.28	10.20
Net energy for lactation (NEl), MJ/kg	6.34	6.59	6.56	6.20
Relative feed value (RFV)	125	142	127	113

Source: Own calculation.

In the literature, there are data on the feed quality of the studied species, presented by different authors. Thus, Nohashkieva [18] reported that the mixture of *Glycyrrhiza glabra* with *Elymus repens* contained 16.43% protein, 2.09% fats, 20.18% crude fibre, 30.57% nitrogen free extract, 10.84% ash. Kamalak [13] mentioned that *Glycyrrhiza glabra* leaves contained 16.19-26.93% CP, 20.74-29.07% ADF, 1.57-10.83% tannins, 58.70-70.59% DDM, 10.14-12.12 MJ/kg ME. Alexeyeva [2] determined that the aerial biomass of the researched ecotypes of *Glycyrrhiza glabra* had a concentration of 12.80-21.40% crude cellulose, 15.67- 25.67% crude protein, 6.80-11.50% soluble sugars, 5.67- 17.40% minerals and 1.30-1.70%

flavonoids, including 9.61-16.30 g/kg Ca, 0.14-0.43 g/kg P, 5.27-9.05 g/kg Mg, 3.20-15.25 mg/kg Cu 18.90-50.62 mg/kg Zn, 22.80-104.10 mg/kg Mn, 112-486 mg/kg Fe and 1.30-1.70% flavonoids. Astafiev et al. [4] in a comparative study, established that the *Glycyrrhiza glabra* feed contained 8.09-8.31% crude protein, 3.01-6.62% fats, 24.87-25.86% crude cellulose, 7.13-9.49% ash, 53.07% nitrogen free extract, 33.94 mg/kg carotene; *Glycyrrhiza uralensis* – 10.04-12.92% crude protein, 0.32-3.47% fats, 21.80-22.65% crude cellulose, 5.51-6.12% ash, 58.57% nitrogen free extract, 55.33 mg/kg carotene; *Glycyrrhiza echinata* – 12.85% crude protein, 8.520% fats, 25.54% crude cellulose, 6.53% ash. Toderich et al. [23] mentioned that liquorice plants had a content of 20.7% crude protein, 4.2% fats, 33.4% crude cellulose, 33.3% nitrogen free extract, 7.51% ash and 18.4 MJ/kg crude energy, and that alfalfa plants contained 16.1%, 1.6%, 11.6%, 60.8%, 9.1% and 17.4 MJ/kg, respectively. During our previous research [21], it was established that *Glycyrrhiza glabra* has a nutrient concentration of 13.80% CP, 3.65% fat, 29.40% crude cellulose, 5.40% ash, 32.30% ADF, 49.50% NDF, 5.90% ADL, 26.4% Cel, 16.7% HC, 47.75% SEN, 65.4% DDM, 56.7% ODM, RFV= 122. Gryazeva [11] reported that the fresh mass of *Onobrychis arenaria* included 238.4-244.6 g/kg dry matter, containing 18.57-19.31 % crude protein, 29.18-29.41 % crude cellulose, 41.93-44.02 % nitrogen free extract, 2.29-2.36 % fats and 5.95-6.90 % ash; it was compared with alfalfa, which contained 248.9-269.6 g/kg dry matter with 18.62-20.66% crude protein, 31.18-32.60% crude cellulose, 37.20-39.17% nitrogen free extract, 2.49-2.52% fats and 7.02- 9.09% ash. In an earlier study [20], it was found that *Onobrychis arenaria* contained 16.6% crude protein, 1.0 % fats, 32.4 % crude cellulose and 34.6 % nitrogen free extract. Coşman et al. [6] conducted a research on the biochemical composition of *Onobrychis arenaria* hay and found that it contained 13.94% crude protein, 2.65% fats, 35.35% crude cellulose, 31.73% nitrogen free extract, 6.98% ash, 0.6 nutritive units/kg, 135 g digestible protein per nutritive unit. Matolinets [15] established that *Onobrychis arenaria* feed in the second year of vegetation contained 12.32-17.26% crude protein, 1.60-2.88% fats, 21.51-27.40% crude cellulose, 5.28-10.13% sugars, 5.80-7.28% ash, 10.07-11.13 MJ/kg metabolizable energy and 0.82-1.00 nutritive units/kg dry matter. Morozkov & Maisak [17] indicated that *Onobrychis arenaria* haylage contained 16.96% crude protein, 4.86% sugars, 2.59% fats, 26.15% crude cellulose, 10.63 g/kg Ca, 2.79 g/kg P, 22.90 mg/kg carotene and 9.50 MJ/kg metabolizable energy. Voloshin et al. [25] found that the concentration of nutrients and energy in the first-cut fresh mass of *Onobrychis arenaria* cultivars was as follows: 14.51-17.70% crude protein, 27.13-28.82% crude cellulose, 2.47-2.72% fats, 6.09-6.44% sugars, 6.13-6.79% minerals, 92.25-137.11 mg/% carotene, 0.78-0.83 nutritive units/kg, 9.81-10.12 MJ/kg metabolizable energy, for comparison, alfalfa contained 17.29% crude protein, 32.02% crude cellulose, 3.22% fats, 8.4% minerals, 3.12% sugars, 100.88 mg /% carotene, 0.69 nutritive units/kg and 9.24 MJ/kg metabolizable energy. Dronova et al. [9] mentioned that *Onobrychis arenaria* plants contained 17.7%% crude protein, 25.0% crude cellulose, 35.6% nitrogen free extract and 3.55% fats. Demydas et al. [8] in a comparative study evaluating different species of the genus *Onobrychis*, assessed the nutrient content of natural fodder, thus, it was found that *Onobrychis arenaria* feed contained 20.5-20.6% crude protein, 21.5-21.9% crude cellulose, 4.16-4.22% fats, 8.09-8.15% ash, 46.00% nitrogen free extract, 13.2-13.3 g/kg calcium and 6.2-6.5 g/kg phosphorus. In the same study, other sainfoin species were evaluated: *Onobrychis viciifolia*, which contained 19.3-19.4% crude protein, 21.2-21.6% crude cellulose, 48.00% nitrogen free extract, 3.48-3.62% fats, 7.80-7.98% ash, 13.4-13.5 g/kg calcium and 5.2-5.6 g/kg phosphorus, and *Onobrychis transcaucasica* – 20.1-20.3% crude protein, 21.5-21.6% crude cellulose, 4.07-4.20% fats, 46.00% nitrogen free extract, 8.06-8.16% ash, 12.6-13.3 g/kg calcium and 6.4-6.6 g/kg phosphorus. Hetman & Veklenko [12] mentioned a productivity of

1.58-1.73 t/ha of crude protein and 89.6-89.9 GJ/ha of metabolizable energy.

The biomethane produced by anaerobic digestion of organic matter is used for obtaining heat, electricity, fuel for internal combustion engines, and the digestate is used as an efficient fertilizer in organic agriculture. The raw material (organic substrate) is the determining factor in biogas production, and the nutrient content and the carbon-nitrogen ratio (C/N) play a key role in the microbial decomposition of organic matter and biomethane productivity [5, 7, 24]. Foam formation is considered one of the most common problems in biogas reactors, and the use of mixtures of legumes and plant species containing tannins would minimize the formation of foam in biogas reactors, with a beneficial effect on methane production efficiency, and environmental protection [1, 14, 16]. The studied substrates for the production of biomethane in anaerobic digesters, Table 2, are rich in protein and have a C/N ratio = 16.54-19.85, moderate content of hemicellulose and lignin, which provide a biomethane production potential of 283-301 l/kg organic matter. It was found that during the conservation process, the lignin content changes and the potential for obtaining biomethane increases in both species. Fardad et al. [10] mentioned that *Glycyrrhiza glabra* substrates have C/N = 19.36 and a biomethane potential of 89.8 l/kg. Amaleviciute-Volunge et al. [3] reported that the methane potential of sainfoin substrate was 277.7 L/kg. In our previous research [13, 14] we found out that the biomethane potential in the fermentable biomass of *Onobrychis arenaria* reached 288 l/kg and of *Glycyrrhiza glabra* – 298 l/kg.

Table 2. Biochemical methane potential of substrates from *Glycyrrhiza glabra* and *Onobrychis arenaria*

Indices	*Glycyrrhiza glabra*		*Onobrychis arenaria*	
	fresh mass	haylage	fresh mass	haylage
Crude protein (CP), g/kg	162	184	167	155
Acid detergent lignin (ADL), g/kg	54	50	48	47
Carbon, g/kg	500.00	487.22	506.67	492.22
Nitrogen, g/kg	25.92	29.44	26.72	24.80
Carbon/nitrogen ratio (C/N)	19.29	16.54	18.96	19.85
Biomethane potential, l/kg MO	283	288	295	301

Source: Own calculation.

CONCLUSIONS

The local ecotypes of *Glycyrrhiza glabra* (liquorice) and *Onobrychis arenaria* (sand sainfoin) are of economic and social interest, to be used in diversifying the range of multi-purpose cultivated plants, which can be grown on poorly productive lands, due to their ability to symbiotically fix nitrogen, in addition, they can be helpful in preventing soil erosion, and the harvested fresh mass can be used to produce various types of fodder for livestock and as substrates for biogas plants, in the production of renewable energy, and as soil fertilizers in organic farming.

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IMPROVING THE QUALITY OF THE PRODUCT "GINGERBREAD", A STUDY ON THE INFLUENCE OF RYE FLOUR ON THE PRODUCT'S PHYSICOCHEMICAL PROPERTIES

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Abstract

The variety of the assortments of gingerbread existing on the market originates from the applied technology, from the quality and diversity of the ingredients used, as well as from the application of quality management: customer orientation and continuous improvement. Upon adding rye flour, an improvement in the quality of the finished product was ascertained. Different quantities of wheat flour were replaced with rye flour, and the doughs were matured for 30, respectively 150 minutes. An analysis was performed regarding the behaviour of the dough, as well as the features of the finished product (shape effect, height/diameter ration, and specific volume), which correspond to the consumer's requirements. These parameters subject to analysis can be considered quality indicators for gingerbread.

Key words*: *gingerbread, rye flour, physicochemical properties, quality indicators

INTRODUCTION

The product "gingerbread" is a leavened dough cake (using baking soda or another chemical substance), made of flour, honey, and various spices (cinnamon, nutmeg, cloves, anise, and even pepper), coated in thick syrup and baked in the oven [9].
In view of improving the quality of the traditional product "gingerbread", ingredients with a positive impact on quality indicators are often used.
Rye flour is widely used in obtaining gingerbread and, in numerous manufacturing recipes, rye flour is seen in various proportions, in combination with wheat flour.
Wheat flour, due to its gluten protein content, helps in obtaining a cohesive, springy, dry dough, which is easily processed, but the products become hard. Rye flour provides for the manufacture of products with a superior, softer texture, but the dough is more difficult to process, it is stickier, less cohesive [1], [8], [7].
This study monitored the effect which the replacement of wheat flour with rye flour has on the products' physicochemical characteristics [2].
Wheat flour was replaced with rye flour in different percentages and the dough obtained was left to mature for 30 and 150 minutes.

MATERIALS AND METHODS

To manufacture gingerbread, the raw materials (Table 2) used in industrial manufacturing were employed, as well.
To prepare the dough, white wheat flour type 650 was used. The characteristics of the flour are presented in Table 1.

Table 1. Technological characteristics of the wheat flour used in the experiment

Ash content, %		0.640
Moisture content, %		14.6
Wet gluten content, %		24.6
Alveograph characteristics	P (mm H_2O)	68
	L (mm)	80
	G	19.9
	W (J)	0.0179
	P/L	0.85
	Ie (%)	50.8

Source: Own results in the laboratory.

Rye flour had a mineral content of 0.950 % and a moisture content of 13.9%.

The inverted sugar syrup and the caramel syrup were industrially manufactured (64% dry matter and respectively 80% dry matter).

Table 2. Gingerbread manufacturing recipe

Raw material	P1	P2	P3	P4	P5	P6
Wheat flour, kg	2.69	2.42	2.15	1.88	1.61	1.34
Rye flour, kg	-	0.27	0.54	0.81	1.08	1.34
Rye flour ratio,%	0	10	20	30	40	50
Sodium bicarbnate, kg	0.04	0.04	0.04	0.04	0.04	0.04
Ammonium bicarbonate, kg	0.02	0.02	0.02	0.02	0.02	0.02
SAPP 28, kg	0.02	0.02	0.02	0.02	0.02	0.02
Clove, kg	0.01	0.01	0.01	0.01	0.01	0.01
Cinnamon, kg	0.04	0.04	0.04	0.04	0.04	0.04
Salt, kg	0.01	0.01	0.01	0.01	0.01	0.01
Lecithin, kg	0.02	0.02	0.02	0.02	0.02	0.02
Vegetable fat, kg	0.18	0.18	0.18	0.18	0.18	0.18
Sorbitol, kg	0.15	0.15	0.15	0.15	0.15	0.15
Glycerin, kg	0.02	0.02	0.02	0.02	0.02	0.02
Honey, kg	0.10	0.10	0.10	0.10	0.10	0.10
Inverted syrup, kg	1.43	1.43	1.43	1.43	1.43	1.43
Caramel, kg	0.29	0.29	0.29	0.29	0.29	0.29

Source: Own results in the laboratory.

RESULTS AND DISCUSSIONS

During the course of the study, dough behaviour, as well as the characteristics of the finished product were monitored.

After mixing, the dough was left to rest between 30 and 150 minutes before processing. During the course of processing, the aspect of the dough was monitored. Thus, the dough without rye flour addition, after a 30-minute rest, has a homogeneous, non-sticky aspect, it was easily processed. These characteristics remained similar after 150 minutes of rest as well, the dough was denser and drier to the feel. As the rye flour proportion increased, the dough became stickier, having a viscous appearance.

The doughs which were allowed 150 minutes of rest were more consistent. These notes are in agreement with the other rheological experiments, indicating that, with the increase of rest time, dough consistency increases due to the absorption of water by the flour components. A reduction in the quantity of gluten in the dough by diluting wheat flour with rye flour leads to less cohesive and stickier doughs.

Also, a lightening in the colour of the dough was noticed as the proportion of wheat flour increases.

The shape effect

Due to the release of gas during baking, the product's volume changes. Initially, the viscosity of the dough decreases in the first baking stage, due to the release of water by the proteins, followed by an increase in viscosity, due to the jellification of the starch [3], [5], [6],[10].

As a result, a product widening process occurs, cumulated with a rising process, due to the release and retaining of gas [4].

Figure 1 presents the change in diameter during baking. The widening percentage was calculated, as a difference between the initial value and the final value in relation to the initial diameter. At the time of their insertion into the oven, the samples had the same dimensions, respectively a diameter of 3.1 cm and a height of 2 cm; later, due to the different rye flour ratios in their composition, the baking behaviour was very different.

With the increase of rye flour proportion, we note that the widening of products upon baking is increasingly reduced.

The differences between samples having differing textures are lower for the 30-minute maturation time.

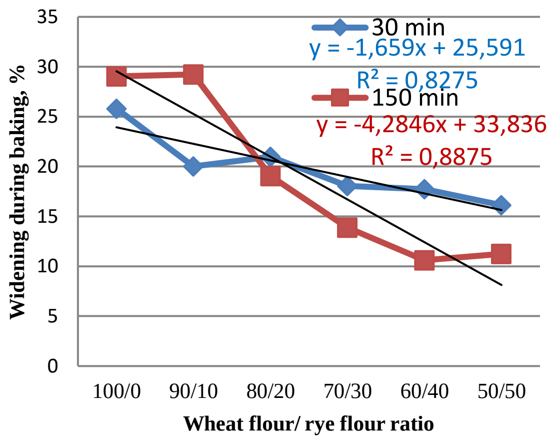

Fig. 1. Widening of cookies during baking
Source: Own results in the laboratory.

The widening of the cake obtained exclusively from rye flour was of 25.8%, whereas for the cake made with 50% rye flour, the widening percentage was 16.1%.

The same samples, after 150 minutes of relaxation had a widening of 29, respectively 11.3%. Apparently, the use of rye flour induced lower widening of the products during baking. The lower jellification temperature of the starch in the rye flower probably induced a faster stabilization of the structure and a reduced flow.

If the results obtained are statistically analysed, a rather good correlation is noticed between the widening of gingerbread and the proportion of used rye flour. In the case of dough allowed a 30-minute maturing time, the linear regression coefficient has a lower value, 0.8275, whereas for cookies prepared from matured dough for 150 minutes, the linear regression coefficient has a greater value, 0.8875. If we also take into account the fact that doughs, as they mature, become harder, more consistent (according to the sensorial observations), we can draw the conclusion that a decisive factor for the widening of gingerbread cookies is the consistency of the doughs. The higher the rye flour ratio, the greater the dough consistency, which leads to lower widening of dough pieces.

However, it has been noted that the gingerbread cookies, although processed in a similar manner, did not have the same mass. The gingerbread cookies prepared with wheat flour had an initial mass of 18.4 grams, whereas the cookies with 50% rye flour had an initial average mass of 15.55 g. If the fact is taken into account that the widening, the flow is conditional upon the weight of the piece of dough, it is very possible that this widening also depends on the mass of the pieces. In order to verify this, the percentage-wise widening of dough pieces was related to the average mass of the samples. The results are graphically illustrated in Figure 2.

The rate of the curves does not change, which indicates the fact that weight has a more reduced role on widening, and that it depends much more on the rheological modifications of dough.

Also, when weighting the widening of the cookies with their initial mass, the best correlation can be noticed in the case of doughs matured over a longer period of time. The linear regression factor increased slightly, from 0.8875 to 0.9143.

In the case of doughs with only a 30-minute rest, the corelation is weaker.

Height/Diameter (H/D) ratio

The height/diameter ratio is a parameter characterising baked goods from a geometrical viewpoint. When the products contain chemical raising agents, this parameter is used to define the development of products during baking (mostly vertically, horizontally, or in both directions) [8].

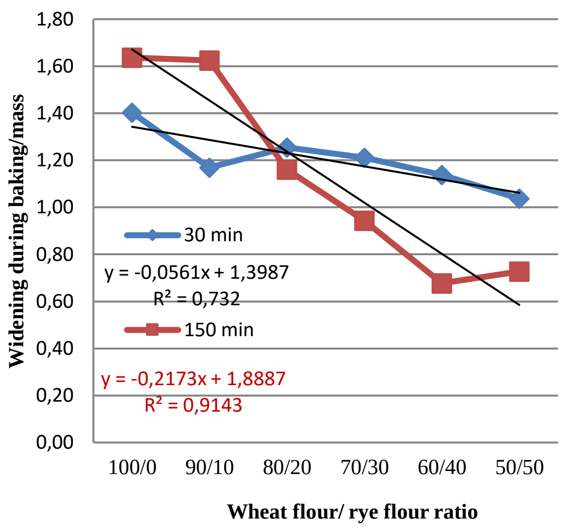

Fig. 2. Widening of cookies in relation to the cookies' average mass
Source: Own results in the laboratory.

Figure 3 presents an analysis of this aspect conducted on the samples having various rye flour percentages. Insignificant differences were noted between the two maturing times. When the proportion of rye flour was enhanced, the height/diameter ratio also increased.

These values are in agreement with the mode in which the diameter of the products changes during baking.

Doughs having a more fluid consistency widened more during baking, these being the ones having a higher wheat flour ratio.

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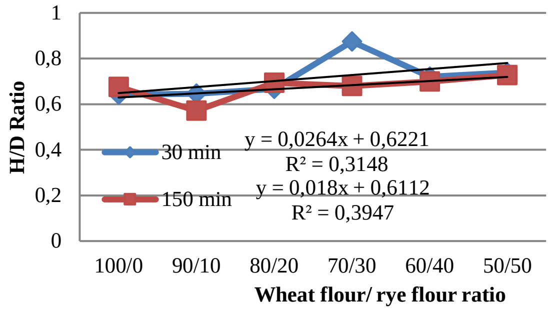

Fig. 3. Height/Diameter Ratio
Source: Own results in the laboratory.

Although constant growth in the H/D ratio is noticed as the rye flour ratio in gingerbread doughs increases, the corelation is very weak, and linear regression factors have values of less than 0.4000. The linear trend slope is very low, 0.026 and, respectively, 0.018. This indicates low variableness, we can practically see a preservation of proportions, of the shape of the products, although an obvious widening was noticed, of 11 and 29%. The almost unchanged preservation of the height-diameter ratio indicates that samples with greater widening also suffered an appropriate height increase.

Specific volume

Specific volume is important for a bakery product from several points of view. First of all, visually, the effect upon a consumer is stronger. If the product is perceived to be bigger, the consumer satisfaction level is higher [9]. Another aspect is that of texture. Bakery products with a larger specific volume have better porosity, the walls are less thick, and, upon pressing, the product feels softer [10]. Consequently, the consumer will perceive the product to be fresher and more pleasant. Another important aspect related to the specific volume is the one concerning the product's dimensions. A too large specific volume will not allow the products to fit in the package provided for them, and a specific volume which is too low will not fill the package sufficiently, the excess space will be too large, and it will allow for an ampler movement of the product in the packaging, which will lead to its damaging during transport and handling.

With regard to gingerbread, these aspects related to specific volume are also valid, just like in the case of other bakery products. Even if the product is eaten occasionally, and the consumer's visual perception is not sufficiently enhanced and refined, the specific volume influences the mode in which the consumers assess the products. Figure 4 presents the variation of the products' specific volume as the proportion of rye flour increases.

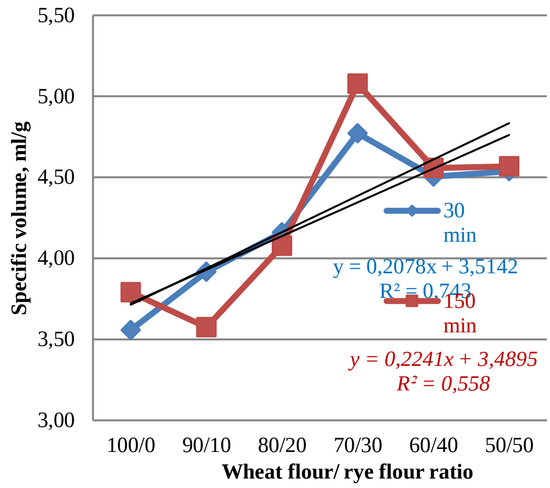

Fig. 4. Specific volume of gingerbread cookies prepared with various proportions of rye flour
Source: Own results in the laboratory.

The tendency is for the specific volume of products to grow with the increase of the rye flour percentage. We can note a certain abnormality in the figure, a deviation of the graph when adding 30% rye flour. Normally, this could be regarded as a work error, as an inconsistency in preparing the samples. However, in the experiments performed as part of the rheological study, a similar inconsistency was noticed, also in the doughs prepared with rye flour to a 30% rate. The dough prepared with 30% rye flour had the lowest consistency and it needed the most time to attain the consistency of 1,000 UB.

If curve rates for the two series of results are traced, corresponding to the 30 and 150 minutes of mixing, we notice that these are almost identical, which indicates that maturation time has no effect in the products' specific volume. The specific volume depends on the rye flour ratio within the mixture. However, there are other factors which influence the samples' specific volume, as linear regression factors are not very high.

During maturation, certain processes take place, which influence the specific volume, as the linear regression factor for the trend curve corresponding to the samples with a 150-minute maturation time is low, namely 0.558.

CONCLUSIONS

As the rye flour ratio increases, the widening of the products upon baking is increasingly reduced. The differences between samples having differing textures are lower for the 30-minute maturation time.

The higher the rye flour ratio, the greater the dough consistency, which leads to reduced widening of dough pieces, weight has a lower impact upon widening.

Also, when weighting the widening of the cookies with their initial mass, the best correlation can be noticed in the case of doughs matured over a longer period of time;

During baking, the doughs with a higher wheat flour ratio are more fluid, they tend to widen more.

Maturation time has no effect on the products' specific volume; the specific volume depends on the rye flour ratio within the mixture. However, there are other factors which influence the samples' specific volume, as linear regression factors are not very high.

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QUALITY IMPROVEMENT FOR THE PRODUCT "GINGERBREAD", IDENTIFICATION OF THE OPTIMUM NUMBER OF TEXTURE MEASUREMENTS AND COMPRESSION INTENSITY IN LABORATORY ANALYSIS

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Abstract

The texture analysis of gingerbread, a bakery product based on flour and many other ingredients, which vary according to its area of origin, within the plant's laboratory, contributes to the improvement of the product quality. In terms of efficiency and effectiveness, the results obtained recommend the minimum number of texture measurement tests needed to be performed, as well as the sample compression rate, in order to obtain relevant results. A TexVol TVT-300XP/XPH texture meter, manufactured by the company Perten Instruments, Sweden, was used, equipped with a 15 kg load cell. The tests were performed using the spherical tip penetration device, with a sphere having a 1-inch diameter, to imitate the mode in which the gingerbread cookies are tested by thumb pressing. To determine the minimum number of texture tests at the level of the laboratory, the two-cycle testing protocol was employed, and, to determine the compression rate, the one-cycle protocol was used. A conclusion was drawn, monitoring hardness, sample deformation energy, cohesiveness, and springiness. The results obtained with regard to the product "gingerbread" can be used in drawing up the work protocol for texture analysis within the plan laboratories which analyse the product "gingerbread".

***Key words*:** *gingerbread, hardness, deformation energy, cohesiveness, springiness*

INTRODUCTION

Lawless and Heymann define texture as "all the rheological and structural (geometric and surface) attributes of the product perceptible by means of mechanical, tactile, and where appropriate, visual and auditory receptors" [7].

This definition emphasizes the strong connection with human perception, using the senses. Sensory characteristics, among which those related to texture, have become very important for the perception of a product by the consumers, and any products which do not meet these requirements and expectations, regardless of their nutritional quality, will not be accepted and will not be successful products. One such example is the one described by Rosenthal A.J., in which the food products specially conceived to provide the nutritional principles needed by American soldiers during World War II were ill-received and caused much discontent [9]. New terms were defined for sensory analysis. One in-depth study on the sensory perception of texture was conducted by Foegeding et all [3]. As part of sensory analysis, texture analysis also became important when it was understood that the perception of food from a hedonistic viewpoint does not only refer to aspect, smell, and taste.

A multitude of specific tests and instruments were elaborated. Whether or not they stood the test of time is due to the mode in which these tests can be corelated with sensory perception. Numerous scientific works aim to explain sensory perception and to discover the mechanical aspects of sensory analysis, as well as to identify the parallels with the texture, which is assessment instrumental in view of elaborating the most accurate tests possible, as close as possible to the consumer's perception [4],[5],[6].

From a statistical viewpoint, the greatest possible number of experiments is needed, to make sure that their average describes the experiment in the most accurate way, but this is not economical, in terms of materials, as well as in terms of the time awarded for the experiments. Further on we will identify the optimum number of texture measurements regarding the quality parameters which characterize the product "gingerbread", as well as the intensity of compression, which need to be used in the laboratory, in view of attaining control along the flow, as well as in view of continuously improving the product, an essential management principle to be followed in the food industry, in order to obtain competitive products.

MATERIALS AND METHODS

To manufacture gingerbread, the raw materials (Table 1) used in industrial manufacturing were employed, as well. The leavening acid, sodium acid pyrophosphate (SAPP) is an important component of double acting baking powder as well as self-rising flour. SAPP reacts in stages and is desirable in baking applications for its slow action [1].

Table 1. Gingerbread manufacturing recipe

No.	Raw material	Quantity, g
1	TOTAL FLOURS	258.07
2	Sodium bicarbonate	3.41
3	Ammonium bicarbonate	1.68
0	SAPP 28	1.68
4	Clove	0.91
5	Cinnamon	3.70
6	Salt	0.82
7	Lecithin	1.73
8	Plant oil	17.30
9	Sorbitol	13.94
10	Glycerine	2.31
11	Honey	9.13
12	Inverted sugar syrup	137.44
13	Caramel	27.87
	TOTAL	**480.00**

Source: Original.

For texture tests, the TexVol TVT-300XP/XPH texture meter manufactured by the company Perten Instruments, Sweden, was used. The instrument was equipped with a 15 kg load cell.

The test device used for both studies was the one with spherical point penetration, with a 1-inch sphere diameter. The device was used to imitate the mode in which gingerbread is tested by thumb pressing, with the sphere imitating the human thumb in shape and size; the relatively large size of the sphere and the limited compression of the product made the mechanical deterioration of the product to be limited [8], [10]. For this reason, a test containing two compression cycles was selected for the study of the optimal number of determinations. The device's circulation speed was of 10 mm/s, the recession speed 10 mm/s, the compression distance 30% of the height, the period of recovery between the two successive tests 10 seconds. This test was defined by several researchers using compression tests and they bear the generic name of Texture Profile Analysis [2]. A number of 16 mechanical tests were performed on 16 pieces of gingerbread with a glazing made of sugar, gelatine, and titanium dioxide, and on a second assortment, which also includes surface decoration with surrogate chocolate sprinkles.

As the purpose of the second experiment was to determine only the compression distance, the testing protocol with a single testing cycle was used.

The 1 inch-diameter ball device was used in the experiment. The speed of the testing device was of 1 mm/s. Industrially manufactured gingerbread was used, prepared according to the same recipe. Some were simple (coded TD), others were coated in glaze (TDG), whereas the last ones were glazed and decorated with surrogate chocolate sprinkles (TDGS). The movement of the device into the product was set at 25, 30 40,50, 60, and respectively 70% of the product height. Each test was conducted on 8 samples.

RESULTS AND DISCUSSIONS

These gingerbread assortments, with glazing, respectively with glazing and surrogate chocolate sprinkles, were selected because the glazing, and in particular surrogate chocolate sprinkles, are quite significantly variable in terms of thickness, which caused the samples to be non-homogeneous from the point of view of structure and texture. The samples were subject to a testing regime consisting of two successive compressions, of 30% from the height of the samples 3, 4 to 16 tests were randomly selected. The average was calculated, as well as the standard deviation of samples (STD%). The texture characteristics defined for this type of determinations are very numerous. We selected hardness as a force needed to achieve deformation, deformation energy (Area 4) as the surface below the curve, cohesiveness as a ratio between two surfaces contained between the two tests, and springiness as a ratio between the routes covered by the test device to achieve the compression indicated in the two cycles. The variation of these statistical indicators, depending on the number of tests conducted for assessment, is presented in Figures 1, 2, 3 and 4.

Upon analysing the graphs, we note a wider variety of statistical parameters when the number of tests performed is reduced, which is statistically normal. For a better appreciation of the size of standard deviation, it was expressed as a percentage as compared to the arithmetic mean of the measured value. In the case of these measurements, we can note that the reliability interval (standard deviation) in which 95% of the measured values are found, is quite large for this product.

Only for product cohesion, the standard deviation will have values representing 10% of the measured average.

For mechanical work, hardness, and springiness, the standard deviation also has values close to 25% of the average measured values.

The high value of the standard deviation indicates a non-homogeneity of the samples or the presence of measuring errors, whatever they may be. From the analysis of the data, we note that the average measured size has a rather low variability, and we see it stabilizing if 6 or more samples are taken into account.

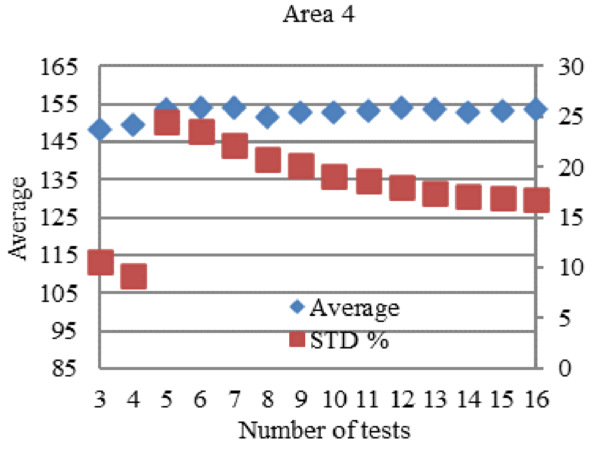

Fig. 1. Variation of deformation energy (Area 4) according to the number of tests
Source: Own results in the laboratory.

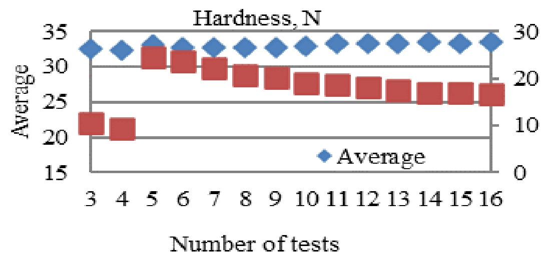

Fig. 2. Variation of hardness according to the number of tests
Source: Own results in the laboratory.

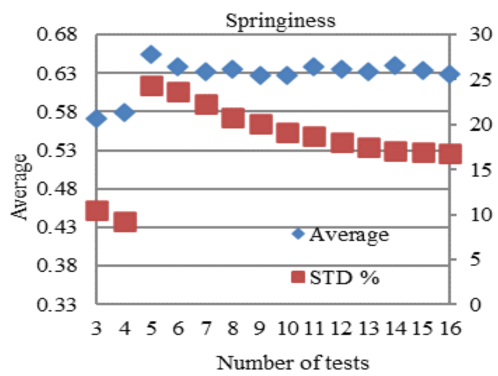

Fig. 3. Variation of springiness according to the number of tests
Source: Own results in the laboratory.

Apart from the optimum number of determinations, another parameter which is just as important is the penetration depth of the test device. An experiment was performed, determining the optimum testing regime, more specifically the optimum depth for the penetration of the test device.

The experiment monitored the mode in which certain texture parameters varied in relation to product compression.

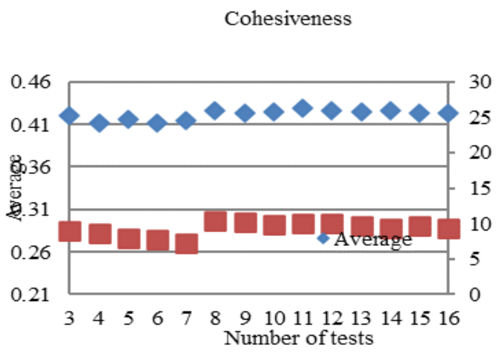

Fig. 4. Variation of cohesiveness according to the number of tests
Source: Own results in the laboratory

In order to identify the compression distance for the sample, several texture measurement parameters were evaluated: hardness, springiness, and mechanical work. We considered these parameters to be representative, and they are sufficient for the product's characterization in terms of texture. Other texture parameters are derived from these, and they were not relevant for the determination. Hardness represents the force registered upon performing the fixed deformation. In the case of this test, this force is identical with the maximum force registered during compression, which indicates that the product did not lose its integrity during testing. The mechanical work is provided by the test device software, in the form of a surface, namely the surface between the curve which represents the variation of the deformation force and the axis along which the distance covered during deformation is registered. As the product of displacement and force is mechanically defined as mechanical work or energy, this value can be associated to the mechanical work needed to distort the product. Springiness refers to a material's capacity to revert to its initial form after deformation. In terms of texture, in the case of this type of testing, springiness is defined as the ratio between the area below the graph upon withdrawing the test device and the area below the graph upon compressing the product.

In Figures 5, 6 and 7, the variation of these textural characteristics is presented.

The fact is noticed that the texture parameters hardness and surface have a similar variation, and springiness presents a different variation model.

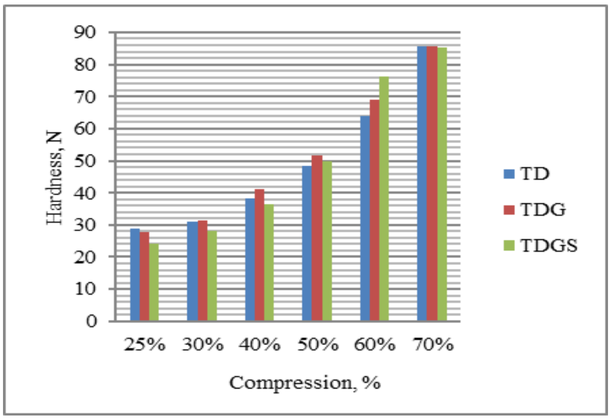

Fig. 5. Variation of gingerbread hardness according to compression distance
Source: Own results in the laboratory.
Note:TD=Simple gingerbread
TDG=Gingerbread coated in glaze
TDGS=Gingerbread glazed and decorated with surrogate chocolate sprinkles

The hardness and surface of the graph saw a continual increase upon compression, the increase being more emphasized as the compression was more intense. Conversely, springiness remained constant, and only on very high deformation values (70%) does it see major growth.

The interpretation is difficult, and it involves the careful monitoring of the variation model for these values. Both hardness, and the surface of the curve saw small variations, up to a 30% distortion, and then they increased.

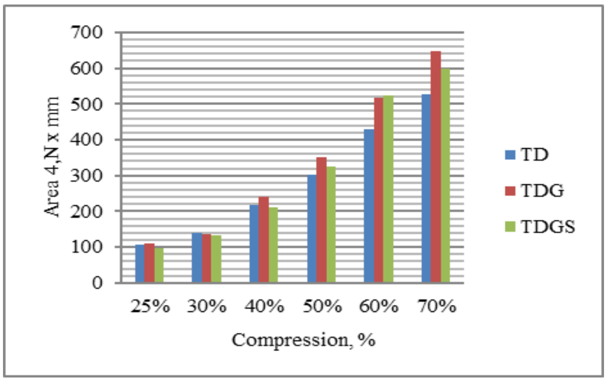

Fig. 6. Variation of gingerbread compression energy in relation to compression distance
Source: Own results in the laboratory.

Note:TD=Simple gingerbread
TDG=Gingerbread coated in glaze
TDGS=Gingerbread glazed and decorated with surrogate chocolate sprinkles

When performing large distortions, the entire sample material was caught under the pressing device and it resisted the advancement of the sample. For small distortions, there was also a lateral slippage, due to the device's spherical shape.

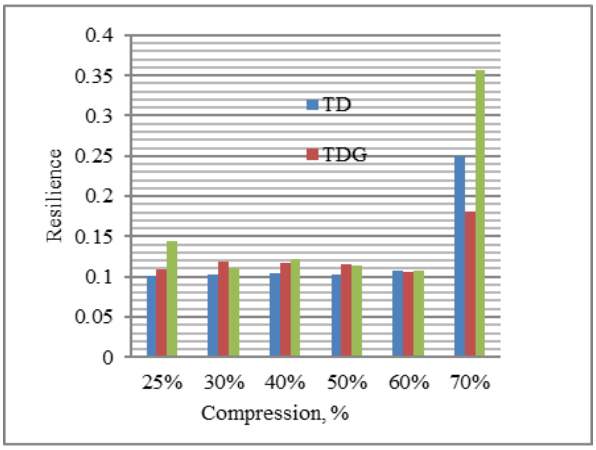

Fig. 7. Variation of gingerbread springiness in relation to compression distance
Source: Own results in the laboratory.
Note:TD=Simple gingerbread
TDG=Gingerbread coated in glaze
TDGS=Gingerbread glazed and decorated with surrogate chocolate sprinkles

Sample springiness varies very little in proportion to the size of the distortion. Springiness, as a ratio of the surfaces delimited by the curves traced upon withdrawal and insertion of the testing device, has low values, of approximately 0.1, up to a 60% compression.
On higher compression, the material was caught between the device and the sample worktop, and upon recovery, it pushed the device with greater energy. In this case, the material changed its behaviour and measurement errors occurred.

CONCLUSIONS

Following this test, we appreciate that the minimum number of tests recommended to be run is 6, in order to obtain representative results.
A 30% compression provides a compression level similar to the one achieved by people at the time of consumption, the material does not undergo major internal fractures, and the displacement of the device is reproducible.

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GRAIN CORN PRODUCT YIELD AND GROSS VALUE DEPENDING ON THE HYBRIDS AND APPLICATION OF BIOPREPARATIONS IN THE IRRIGATED CONDITIONS

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Abstract

Modern crop production is aimed to decrease anthropogenic loads on environment due to the replacement of chemical pesticides with biological preparations. The study on the efficiency of biological preparations Fluorescein BT, Trichopsin BT, and Biospectrum BT in corn hybrids of different ripeness groups (FAO 190, 290, and 420), cultivated in the conditions of irrigation in the Steppe zone of Ukraine, was conducted during 2018–2020. The goal of the study was to evaluate the level of technical efficiency of the biopreparations against common diseases (corn smut and fusarium of the cob) and insect (European corn borer), and their impact on the crop yield. It was determined that the studied biopreparations decreased corn smut infestation rate in the hybrids of corn by 1.7–4.2%, while the infestation rate of fusarium disease dropped by 1.6–3.9%. European corn borer infestation was reduced under the application of Trichopsin BT and Biospectrum BT, which possess insect-fungicidal and growth-promoting effects, by 2.7–4.6% depending on the genotype of the hybrids. High technical efficiency of the studied preparations was determined: Fluorescein BT against corn smut showed technical efficiency of 24.0–30.4%; Trichopsin BT – 38.2–57.9%; Biospectrum BT – 46.0–58.6%, respectively. Application of the biological preparation Fluorescein BT provides the formation of the highest grain yield of corn, which averaged to 14.89 t/ha. The maximum yield in the study was recorded for the hybrid Arabat (FAO 420) under the application of the biopreparation Fluorescein BT – 17.06 t/ha. At the same time, this variant provided the highest gross value of the grain product – 3,968 EUR/ha. The study results provide a proof of high efficiency of the studied biological preparations in the corn cultivation under irrigation.

Key words: *biological preparations, corn smut, European corn borer, fusarium, yield, gross value*

INTRODUCTION

The formation of highly productive crops of spring cereals, including corn, is strongly dependent on the soil-climatic zone of cultivation, the general level of agriculture, soil fertility and varietal traits. Therefore, the increase in grain yield is inextricably linked with the improvement and optimization of the basic elements of cultivation technology. One of the most important and effective among them is plant nutrition. Creating a favorable nutritional background plays an exceptional role for the growth and development of corn plants, the formation of their vegetative mass and significant increase in grain yield with high indices of quality [14].

The issue of preserving soil fertility and increasing crop yields has always been relevant to mankind. The chemicalization and intensification of agriculture have given us answers to all possible questions. However, significant side effects of these systems, in particular environmental aspects, have brought agricultural producers to a standstill. Intensive production, on the one hand, requires a scientifically sound system that would allow to obtain the highest yields at the lowest material and technical expenses without reduction of soil fertility, and, on the other hand, would be as environmentally friendly as possible. At the same time, the use of only organic fertilizers in production does not justify itself due to their high cost and significant volumes needed [15].

All these facts push modern farmers around the world to move to so-called alternative

technologies, which provide for the following goals:
-a more complete combination of production and natural processes;
-reduction of the use of preparations and fertilizers that are harmful to the health of agricultural workers;
-increase in the production use of biological and genetic potential of plants (selection of the most productive, disease-resistant varieties);
-improvement of production processes;
-obtaining environmentally friendly, safe for the consumers' health products;
-use of energy and environmental saving technologies.

Increasingly popular in agricultural production is the direction aimed at the increase in the environmental friendliness of agriculture. The biological method of plant protection (biological control or biocontrol) in its narrow classical sense is a method of controlling pests, weeds and plant diseases using natural enemies. It is based on natural mechanisms ("predator - victim", "parasite - host") and active human intervention in the process of regulation and suppression of pests and pathogens [2].

Increased attention is paid to plant protection in agricultural production because pests and plant diseases can significantly reduce crop yields and agricultural production. According to analysts, more than a third of the losses in the agricultural sector fall on the destruction of crops by pests and plant diseases. Every year, due to the influence of dangerous plant pests, 40% of crop yields are lost [24, 37].

The consequence of excessive fascination with chemical methods of plant protection is an increase in biocenoses and, especially in agrocenoses, threatening phenomena associated with contamination of plants, soils, water, and food by chemical pesticide residues, reduced resistance of pests to pesticides, impaired ecosystem resilience due to the loss of a part of biota as a result of the action of chemicals. This adversely affects human health and environment [3].

The study of the impact of biological preparations with growth-regulating properties is promising and relevant, especially in the context of climate change. Analysis of the literature indicates that the use of biopreparations promotes opening of the potential inherent in the body, including certain immune responses, increases plant productivity and promotes the implementation of genotypic traits of varieties and hybrids. The issue of widespread use of biological preparations in agriculture is given considerable attention in most economically developed countries: France, Great Britain, Germany, Switzerland, the United States, and others [13, 16].

A particular interest in the biological method as a means of wide production application in agricultural production appeared in the 60s of the last century. This gave impetus to new studies of the bio method in plant protection, in particular the conditions of inclusion in the general processes of greening of agriculture, the development of new technological solutions to improve the efficiency of biocontrol and integrated methods of its application [11, 12, 26, 27]. Practical industrial production and use of biological preparations have been studied by numerous foreign and Ukrainian scientists [10, 19, 20, 25, 32, 33, 34].

In Ukraine and abroad, post-industrial agricultural production is being developed using biotechnological alternatives for fertilization and biological protection of plants, precision agriculture, minimization of soil structure degradation. The use of biological preparations allows to reduce the anthropogenic load of agricultural production on the environment with a simultaneous reduction of energy and material costs and increase the quality of the obtained products [1, 22, 23].

The Institute of Genetics, Physiology and Plant Protection of Moldova has found that in the plant body of corn with the use of bacterial strains *Pseudomonas putida* and *Bacillus subtilis* photosynthetic activity is increased, the aging of the leaf surface is delayed, biological potential is enhanced, immune system is strengthened, the level of damage by diseases and insects decreases. Under the influence of biologically active substances, the mass of the root system increases and the biometric parameters of the cob increase, which leads to higher yields [21].

Along with chemical and biological methods of plant protection, plant breeding methods to increase plant resistance to adverse environmental conditions have become more important. The primary tasks of modern plant breeding are to create a source material resistant to adverse bio- and abiotic factors [4].

Corn is affected by pathogens of many infectious diseases, especially in the Southern Steppe of Ukraine under irrigation, where optimal conditions are created for their development.

Each of the pathogens has its own biological characteristics, a certain cycle of development and causes specific symptoms of a disease. The most dangerous are mold fungi of the genera: *Aspergillus, Penicillium, Fusarium, Trichoderma lignorum* (Tode) Harz. The following metabolites cause great damage to grain: aflatoxins, ochratoxins, zearalenone, cayic, penicilic, fusaric acid [31]. The predominance of one or another species of fungus in the complex of pathogens does not always indicate that it poses a major threat. Fungi with severe toxicity in the studied sample could be present in small quantities. Since cereals suffer from the action of common pests, in the experiments of Edel-Hermann, Lecomte devoted to determination of the effect of fusarium wilt on germination and seedling growth it was found out that at 100% infection at the time of seed germination provided the germination rate of 90-94% compared to control, while wheat and rye grain was severely affected by fungi and lost germination by 10-15 % [9]. Some species of *Fusarium* do not reduce the germination of infected grain but inhibit the growth and development of sprouts and roots [5]. Thus, according to Dudka, if the incidence of seedling mold is 20–25% (in some years it can go up to 70%), then the field germination decreases by 3–9%, which leads to a strong thinning of crops [8]. Surviving plants are characterized by inhibition of growth processes and have low productivity. The loss of corn yield from diseases because of mold-infected seeds and sprouts is 0.9–6.5 cwt/ha [17]. With severe fusarium wilt, the weight of 1000 grains are halved [36]. A highly effective measure of protection against pathogenic microflora is the treatment of corn seeds with fungicides. In terms of efficiency, the chemical measure outperforms all others and requires consideration of phytosanitary status and environmental safety [7, 35].

The need to preserve the environment and improve the hygiene of production determines the need to find safe measures to protect corn crops, to study the possibility of using biological preparations. We have worked to identify preparations of biological origin for the treatment of corn, which would reliably protect seeds and plants from soil microflora after sowing in the field.

The goal of the study is to improve the existing technology of cultivation innovative corn hybrids on the irrigated lands by determining the impact of new biological preparations on the plant disease and pest infestation and seed yield under irrigation in the Southern Steppe of Ukraine. The goal is achieved through the selection and scientific substantiation of the most effective preparations for the relevant groups of ripeness of hybrids under drip irrigation, which will increase the yield of corn hybrids using environmentally friendly biological preparations.

MATERIALS AND METHODS

The study was conducted in 2018–2020 at the experimental field of the Institute of Irrigated Agriculture of NAAS. Factor A studied different ripeness groups of the corn hybrids Stepovyi, Kakhovskyi, Arabat, Chongar, and selections of the Institute of Irrigated Agriculture of NAAS. Factor B - treatment of parental components of corn with innovative Ukrainian biological preparations Fluorescein BT, Trichopsin BT, Biospectrum BT. Biopreparations were used to treat seeds before sowing and plants during the growing season according to the recommendations of the Engineering and Technological Institute "Biotechnics" NAAS (Odesa).

Trichopsin BT. Microbiological preparation of insect-fungicidal and growth-stimulating action. The active formulation of the drug is mycelium, fungal spores of the genus *Trichoderma* and rhizosphere bacteria of the genus *Pseudomonas* with a titer of not less than $2.0×10^{10}$ CFU/cm^3, as well as biologically active substances produced by producer strains.

Fluorescein BT. Microbiological preparation with fungicidal and growth-stimulating action. Contains rhizosphere bacteria of the genus Pseudomonas with a titer of not less than $5.0×10^9$ CFU/cm^3, as well as biologically active substances (BAS): phenazine-carboxylic acids, siderophores, cytokinin.

Biospectrum BT. Microbiological preparation of insect-fungicidal action. Contains rhizosphere bacteria of the genus Pseudomonas with a titer of not less than $5.0×10^9$ CFU/cm^3, biologically active substances (BAS): acids of the genus phenazine-carboxylic, a complex of active pigments that are active factors in the preparation.

The cultivation technology of corn was generally accepted for irrigated conditions and met the requirements of corn production technologies for agroecological conditions of the Steppe zone of Ukraine [30].

During the growing season, phenological observations and biometric records were performed according to appropriate methods. After harvesting a structural analysis of the cobs was performed in the laboratory of the Institute.

The experiments were performed under irrigation. The main criterion for planning the irrigation regime was the level of pre-irrigation soil moisture (LPSM).

The biologically optimal regime of corn irrigation is the regime in which at all the stages of the plant organogenesis LPSM is maintained at the level of 80% FC.

The methodology of the study is generally accepted for field experiments in the conditions of irrigation and plant breeding studies with corn plant [29]. The technical efficiency of the preparations was calculated according to the method of Tribel et al. [28].

RESULTS AND DISCUSSIONS

Corn smut (*Ustilago zeae* (Beckm) Unger.). The disease is widespread but causes the greatest damage in the semi-arid central regions of the Steppe zone, especially on susceptible hybrids, affecting 10-25% of plants.

Harmfulness of corn smut depends on the place and time of the infestation, the intensity of spreading. High temperatures and periodic droughts, as well as damage to plants by Swedish flies, *Phyllotreta*, European corn borer and other insects, and mechanical trauma during tillage and sandstorms are the most favorable conditions for the development of corn smut [6].

Fusarium wilt is one of the most difficult diseases of corn, as there are many species of Fusarium that cause the disease. Fusarium wilt is the most common and dangerous disease in the irrigated lands of southern Ukraine. Irrigation and high air temperature contribute to the development of the disease. Harmfulness of fusarium root and stem rot is manifested in the thinning of crops, reduction in the productivity of infested plants. Severe damage to corn cobs leads to a decrease in cob length, grain weight, loss of seed germination capacity [18].

The studied biological preparations had a positive effect on increasing resistance to fungal diseases. In the early-ripening hybrid Stepovyi, all the biological preparations had a positive effect on the reduction of the intensity of infestation of with corn smut (Ustilago zeae Beckm.).

The biological preparation Fluorescein BT reduced the manifestation of the disease compared to untreated control by 1.7%, the biological preparation Trichopsin BT – by 3.0%, the biological preparation Biospectrum BT – by 2.9%, respectively (Table 1).

There was a decrease in the incidence of corn smut (*Ustilago zeae* Beckm.) on the plants of middle-ripening hybrid Kakhovskyi due to the use of the biological preparation Fluorescein BT by 1.7%, the biological preparation Trichopsin BT reduced the incidence by 2.1%, while the biological preparation Biospectrum BT provided the reduction of 4.0%.

Table 1. Effect of treatment with biopreparations on the intensity of corn hybrids infestation, % (average for 2018–2020)

Hybrid (Factor A)	Treatment with biopreparations (Factor B)	Intensity of infestation, %		
		Corn smut (*Ustilago zeae Beckm.*)	Fusarium of the cob (*Fusarium moniliforme Scheld.*)	European corn borer (*Ostrinia nubilalis*)
Stepovyi (FAO 190)	Control, no treatment	6.3	9.3	15.4
	Fluorescein BT	4.6	7.3	15.4
	Trichopsin BT	3.3	7.5	11.8
	Biospectrum BT	3.4	6.4	10.8
Kakhovskyi (FAO 290)	Control, no treatment	7.6	7.7	15.8
	Fluorescein BT	5.9	5.9	15.8
	Trichopsin BT	5.5	4.7	11.3
	Biospectrum BT	3.6	3.6	11.4
Chongar (FAO420)	Control, no treatment	7.5	8.8	10.7
	Fluorescein BT	5.7	6.6	10.7
	Trichopsin BT	3.4	5.9	9.9
	Biospectrum BT	3.3	5.8	9.7
Arabat (FAO420)	Control, no treatment	6.9	8.3	11.4
	Fluorescein BT	4.8	6.6	11.4
	Trichopsin BT	2.9	5.9	9.9
	Biospectrum BT	2.9	5.7	8.7
LSD		0.22	0.21	0.27

Source: Own study.

The studies have shown that in the middle-late hybrid Chongar, the reduction in disease from the use of the biological preparation Fluorescein BT was 1.8%, the biological preparation Trichopsin BT reduced the manifestation of the disease by 4.1%, and the biological preparation Biospectrum BT – by 4.2%.

In the middle-late hybrid Arabat, biopreparations also reduced the development of corn smut (*Ustilago zeae* Beckm.). The biological preparation Fluorescein BT reduced the incidence of the disease by 2.1%, the biological preparation Trichopsin BT and the Biospectrum BT did it by 4.0%.

The incidence of fusarium cob blight also decreased with the use of biological preparations (Table 1). The most effective preparation was Biospectrum BT. Incidence of fusarium cob blight in the hybrids decreased by 1.6–2.9%. The hybrid Kakhovskyi was characterized by the lowest incidence of cob fusarium with the use of the preparation Biospectrum BT – 3.9%.

Infestation with European corn borer was reduced with the use of biological preparations Trichopsin BT and Biospectrum BT, which possess insect-fungicidal and growth-stimulating effects. The reduction in the incidence was 2.7–4.6% depending on the genotype of the hybrids.

The studied biological preparations showed high technical efficiency in the studied diseases. Biopreparation Fluorescein BT showed technical efficiency against corn smut ranging within 24.0% to 30.4%. The biological preparation Trichopsin BT showed a technical efficiency of 38.2% to 57.9%. A biopreparation Biospectrum BT showed technical efficiency from 46.0% to 58.6%, respectively (Table 2).

Technical efficiency of the biological preparation Fluorescein BT against the disease of fusarium cob blight (*Fusarium moniliforme* Scheld.) ranged from 20.5 to 25.0%, the biological preparation Trichopsin BT showed technical efficiency of 19.4 to 38.9%. The biopreparation Biospectrum BT showed technical efficiency from 31.3 to 53.2%.

Table 2. Technical efficiency of the used biopreparations on the corn hybrids, %

Hybrid (Factor A)	Treatment with biopreparations (Factor B)	Technical efficiency, %		
		Corn smut (*Ustilago zeae Beckm.*)	Fusarium of the cob (*Fusarium moniliforme Scheld.*)	European corn borer (*Ostrinia nubilalis*)
Stepovyi (FAO 190)	Control, no treatment	-	-	-
	Fluorescein BT	27.0	21.5	-
	Trichopsin BT	47.6	19.4	23.4
	Biospectrum BT	46.0	31.2	29.8
Kakhovskyi (FAO 290)	Control, no treatment	-	-	-
	Fluorescein BT	28.8	23.4	-
	Trichopsin BT	38.2	38.9	28.4
	Biospectrum BT	58.6	53.2	27.8
Chongar (FAO 420)	Control, no treatment	-	-	-
	Fluorescein BT	24.0	25.0	-
	Trichopsin BT	54.7	32.9	7.5
	Biospectrum BT	56.0	34.1	10.3
Arabat (FAO 420)	Control, no treatment	-	-	-
	Fluorescein BT	30.4	20.5	-
	Trichopsin BT	57.9	28.9	15.1
	Biospectrum BT	57.9	31.3	23.7

Source: Own study.

Technical efficiency of the biological preparation Trichopsin BT under the infestation of corn plants with European corn borer (*Ostrinia nubilalis*) ranged from 7.5 to 28.4%, the biological preparation Biospectrum BT showed technical efficiency of 10.3 to 29.8%. The biological preparation Fluorescein BT is not an insecticide, so it had no effect on European corn borer (*Ostrinia nubilalis*).

Productivity formation of any crop depends on many factors. First, soil and climatic conditions of the cultivation area, varietal or hybrid composition, seed quality, sowing dates, application of pesticides, strict adherence to all methods of cultivation technology is of great importance [18].

The results of the corn hybrids yield estimation showed that under the influence of agrotechnical elements in the conditions of irrigation, the productivity of the studied corn hybrids, on average, ranged from 11.69 to 17.06 t/ha (Table 3).

It was found that the treatment with the biological preparation Fluorescein BT promotes the formation of the highest grain yield of corn, which averaged to 14.89 t/ha. At treatment with Trichopsin BT, the grain yield of corn was slightly lower – 14.78 t/ha. At treatment with Biospectrum BT, the grain yield of corn was 14.45 t/ha.

In comparison with the control, the increase in the yield from the application of the preparation Fluorescein BT was 1.34 t/ha or 9.9%. The increase in the yield from the application of the preparation Trichopsin BT was 1.23 t/ha or 9.1%, the increase in the yield from the application of the preparation Biospectrum BT was 0.90 t/ha or 6.6%.

The hybrid Arabat, on average during the period of the study, turned out to be the most productive – the average grain yield was 16.74 t/ha.

The maximum yield of the hybrid Arabat was obtained under treatment with Fluorescin BT – 17.06 t/ha, slightly lower yield was obtained in the variants with the hybrid Chongar – 16.74 t/ha.

The maximum yield of the hybrid Stepovyi of 12.27 t/ha was obtained under treatment with the preparation Fluorescein BT, the yield increase is 0.88 t/ha or 4.9%.

The hybrid Kakhovskyi provided the maximum yield under treatment with the preparation Fluorescein BT – 13.65 t/ha, the increase from the use of the preparation was 0.78 t/ha or 6.1%.

The highest gross value of the grain product was provided by the hybrid Arabat (FAO 430) AND on the variants with the biopreparation Fluorescein BT. Early-ripening hybrid Stepovyi (FAO 190) and the biopreparation Biospectrum together with the control (no treatment with biopreparation) provided the lowest gross value of the corn grain product per hectare.

Table 3. Effect of the biopreparations on the grain yield of the corn hybrids of different ripening groups, t/ha (average for 2018–2020)

Hybrid (Factor A)	Treatment with biopreparations (Factor B)				Average for the Factor A
	Control, no treatment	Fluorescein BT	Trichopsin BT	Biospectrum BT	
Stepovyi (FAO 190)	11.69	12.27	12.19	11.64	11.95
Kakhovskyi (FAO 290)	12.87	13.65	13.38	13.08	13.25
Chongar (FAO 420)	16.05	16.74	16.58	16.35	16.43
Arabat (FAO 430)	16.45	17.06	16.78	16.67	16.74
Average for the Factor B	13.55	14.89	14.78	14.45	14.42
Partial differences significance LSD_{05}: A = 0.24; B = 0.16					
Major effects differences significance LSD_{05}: A = 0.15; B = 0.14					

Source: Own study.

Table 4. Gross value of the grain corn yield in different hybrids under the treatment with biopreparations (average for 2018–2020), EUR/ha

Hybrid (Factor A)	Treatment with biopreparations (Factor B)				Average for the Factor A
	Control, no treatment	Fluorescein BT	Trichopsin BT	Biospectrum BT	
Stepovyi (FAO 190)	2,719	2,854	2,835	2,707	2,779
Kakhovskyi (FAO 290)	2,994	3,175	3,112	3,042	3,081
Chongar (FAO 420)	3,733	3,894	3,857	3,803	3,822
Arabat (FAO 430)	3,826	3,968	3,903	3,877	3,894
Average for the Factor B	3,318	3,473	3,427	3,357	

Source: Own study. The gross value of the product was calculated using the prices on FOB Ukraine dated for July, 02, 2021.

CONCLUSIONS

The biopreparations had a positive effect on the resistance to fungal diseases. In the early-ripening hybrid Stepovyi, all the biopreparations reduced the intensity of corn smut infestation (*Ustilago zeae* Beckm.): the biopreparation Fluorescein BT reduced the manifestation of the disease in comparison with the untreated control by 1.7%, the biopreparation Trichopsin BT by 3.0%, and the biopreparation Biospectrum BT – by 2.9%. On the middle-ripening hybrid Kakhovskyi, the application of the biological preparation Fluorescein BT decreased the infestation by 1.7%, the biological preparation Trichopsin BT reduced the manifestation of the disease by 2.1%, the biological preparation Biospectrum BT – by 4.0%. On the middle-late ripening hybrid Chongar, the manifestation of the disease decreased due to the application of the biological preparation Fluorescein BT by 1.8%, the biological preparation Trichopsin BT reduced the manifestation of the disease by 4.1%, the biological preparation Biospectrum BT – by

4.2%. On the middle-late ripening hybrid Arabat, the biological preparation Fluorescein BT reduced the incidence of the disease by 2.1%, the biological preparation Trichopsin BT and the Biospectrum BT – by 4.0%, respectively.

The infestation with fusarium cob blight has also decreased under the use of biological preparations - the most effective one was Biospectrum BT. The infestation with fusarium cob blight in the hybrids decreased by 1.6–2.9%. The hybrid Kakhovskyi had the lowest infestation rate with cob fusariosis under the application of the preparation Biospectrum BT – the infestation decreased by 3.9%.

European corn borer infestation was reduced under the application of Trichopsin BT and Biospectrum BT, which have insect-fungicidal and growth-promoting effects. The reduction in the infestation was 2.7–4.6% depending on the genotype of the hybrids.

High technical efficiency of the biological preparations was determined: Fluorescein BT against corn smut showed technical efficiency of 24.0% to 30.4%. Trichopsin BT showed technical efficiency of 38.2% to 57.9%, Biospectrum BT showed technical efficiency of 46.0% to 58.6% against corn smut.

Treatment with the biological preparation Fluorescein BT favors to the formation of the highest grain yield of corn, which averaged to 14.89 t/ha. At treatment with Trichopsin BT, the grain yield of corn was slightly lower – 14.78 t/ha. At treatment with Biospectrum BT, the grain yield of corn was 14.45 t/ha.

The maximum yield in the study was recorded for the hybrid of the middle-late ripening group Arabat under treatment with the preparation Fluorescein BT – 17.06 t/ha. This variant provided the highest gross grain product value of 3,968 EUR/ha.

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POLICY FOR THE DEVELOPMENT OF CUSTOM VILLAGES INTO A DIGITAL-BASED TOURISM VILLAGE THAT CAN ADAPT TO THE NEW NORMAL ERA (CASE STUDY OF CUSTOM VILLAGES IN BALI, INDONESIA)

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Abstract

The province of Bali, which relies on tourism as a driving force for the economy, is certainly very affected by the COVID-19 pandemic. The decline in foreign tourist arrivals to Bali has made the government and tourism actors begin to look at domestic tourists. Given the existence of tourism sector workers who return to the village, the development of tourist villages through the participation of local communities is very potential to be developed. The purpose of this research is to develop a policy framework for the development of custom villages as digital-based tourism villages that are able to adapt to the new normal era. This study used a MULTIPOL prospective analysis, where data were collected through FGDs. The policies analyzed are tourism village policies and digital villages, both in supply side and demand side scenarios. The results show that in the tourism village policy, the program arrangement of tourist objects/attractions is a priority. Meanwhile, in digital village policies, the development and improvement of information network programs are important.

Key words: *tourism village, digital village, prospective analysis, multi policy*

INTRODUCTION

To prevent the spread of the Corona virus, the government urges the public to carry out activities at home (stay at home), whether to work, study, or worship. The public is also advised to stay away from crowds and reduce travel, including traveling. This resulted in public places and tourist destinations being deserted and many not operating [14]. The same thing happened in Bali Province, where the mobility of people outside the home has decreased compared to conditions before the COVID-19 pandemic (Figure 1).

The province of Bali, which relies on tourism as a driving force for the economy, is certainly very affected by the COVID-19 pandemic. Workers in the tourism sector in Bali lost their jobs or changed professions, some decided to return to the village, so that there was an increase in the growth of the number of workers in the agricultural, forestry and fisheries sectors.

Fig. 1. Changes in Community Mobility in Bali Province (per 28 September 2021)
Source: Google Mobility Report (2021).

The decline in foreign tourist arrivals to Bali has made the government and tourism actors begin to look at domestic tourists. Given the existence of tourism sector workers who return to the village, the development of tourist villages through the participation of local communities is very potential to be developed. The village is a territory that is closely related to cultural similarities, as well as relatively easier control, so that the application of CHSE-based tourism (Cleanliness, Health, Safety, Environment) can be applied.

Tegallinggah Custom village is one of the custom villages in Bali that develops rural tourism, but already has adequate objects and supporting facilities. Such as the tourist attraction Tegallinggah Cliff Temple as known as *Candi Tebing Tegallinggah* (Figure 1). In addition, there are several villas and homestays (Photo 1 and 2) and a variety of innovative art attractions developed by the local community (Photo 3).

Photo 1. Tourist Attractions at Tegallinggah Custom Village
Source: Documentation of Tegallinggah Custom Village (2021).

Photo 2. Tourism Support Facilities at Tegallinggah Custom Village
Source: Own documentation (2021).

Photo 3. Art Attraction at Tegallinggah Custom Village
Source: Documentation of Tegallinggah Custom Village (2020).

The government considers Bali as the best area in handling COVID-19, because of the role of Custom villages [7], so that the development of digital-based tourism villages is expected to adapt to the new normal era. Moreover, Indonesia has sufficient capacity to implement the concept of a digital village [12]. So that the purpose of this research is to develop a policy framework for the development of custom villages as digital-based tourism villages that are able to adapt to the new normal era. The new normal era is an era where people are back to being productive and active because they have lived side by side with Covid-19 [9].

MATERIALS AND METHODS

Tourism Village Concept

A brief understanding of tourist villages is stated in the Minister of Culture and Tourism Regulation No. KM18/HM.001/MKP/2011 concerning Guidelines for the National Community Empowerment Program (PNPM) of Tourism Mandiri. Tourism village is an interaction between tradition and the dimensions of tourism (attractions, accommodation, and supporting facilities) in a structure of rural community life.

Tourism villages provide tourism with various local resources owned and managed [5]. In tourism villages, usually a small group of tourists can learn about village life and environment by living or close to traditional life in rural areas [6]. Each tourism village optimizes the potential of its village as a tourism attraction, so that existing resources can grow and local communities get additional income [15]. Through the development of tourist villages, it will be able to support the economy of the local community through the growth of local entrepreneurs and see tourism products, as well as being able to simultaneously revitalize local culture [11].

Tourism Policy Analysis

The process of policy analysis is a series of intellectual activities carried out in the process of activities that are basically political in nature which are described as the policy-making process. In full, the process is visualized as a series of stages which include: agenda setting, policy formulation, policy adoption, policy implementation, and policy assessment [3]. In Indonesia, many tourism villages have been established, where these villages continue to make efforts to develop their tourism [10]. The government also supports these efforts by participating in formulating tourism development policies that are oriented towards making tourism a mainstay and leading sector. The government believes that tourism will be able to encourage economic growth and increase regional income, as well as a source of foreign exchange. In addition, tourism is believed to have a real impact on the welfare of the community, through the expansion of job opportunities and empowerment of the people's economy, of course without ignoring the issue of environmental sustainability and quality as well as maintaining the nation's personality [13].

Digital Village Concept

Digital village is a program concept that implements government service systems, community services, and community empowerment based on the use of information technology [1]. The development of digital villages is generally influenced by several factors. First, the education level of the community in the village, especially in terms of information technology. Second, access to information technology, and third is the seriousness of the government's efforts to introduce information technology to the public [16].

Research Methods

Policy analysis is a tool for synthesizing information to be used in formulating policy alternatives and preferences which are stated comparatively, predicted in quantitative and qualitative language as a basis or guide in making policy decisions [8]. The public policy analysis used in this study is a prospective policy analysis. Economists, systems analysts, and operations researchers conduct prospective policy analyzes based on the information obtained and then transformed before a policy can be started for implementation [3].

It was further explained that the prospective analysis technique to be used was MULTIPOL analysis. MULTIPOL in question are “MULTI-criteria” and “POLicy” with an integrated participatory approach. The three main elements in the MULTIPOL analysis are scenario, policy (policy direction), actions. Potential policy pathways that can be drawn up through MULTIPOL analysis. The data used in the MULTIPOL analysis comes from FGDs with stakeholders or experts who understand the research topic.

RESULTS AND DISCUSSIONS

Determination of MULTIPOL Input Components

As explained in the research method, the MULTIPOL analysis technique is based on criteria, policies, and actions in various scenarios. Therefore, at the initial stage, the components are determined in advance.

The policies to be analyzed are tourism village policies and digital village policies. Furthermore, Table 1 also presents policy actions to realize tourism village policies and digital villages, including actions on disaster mitigation which are very important in the new normal era. The next input components are criteria and scenarios. For input scenarios, a supply side and demand side based rural development approach is used [4][2]. The supply side is more focused on investment in human resources, research and development, and capital formulation. While the demand side is emphasized on economic injection in the form of transfer funds and public spending (Keynesian approach to rural development).

Table 1. Input Components of MULTIPOL Analysis on Development of Custom villages as Digital-Based Tourism Villages

No	Policy	Symbol	Weight
1	Tourism village	tour.vil	5
2	Digital village	digi.vil	4
No	**Policy Action**	**Symbol**	
1	Arrangement of tourist objects/attractions	tour.obj	
2	Development and strengthening of rural infrastructure	vil.infra	
3	Development and improvement of information network	ict	
4	Strengthening of rural community business unit (MSME)	msme	
5	Increasing community skills in tourism	tour.skill	
6	Empowerment of community groups	empowerment	
7	Increasing community knowledge in disaster mitigation	mitigation	
8	Increasing community's digital literacy	digi.liter	
No	**Criteria**	**Symbol**	
1	Increased income	income	5
2	Increased competitiveness	competitive	5
3	Absorption of workers/employment	employment	5
4	Growth of new business	business	5
5	Environmental sustainability	environment	5
6	Infrastructure improvement	infrastruc	4
7	Existence of events/tour packages	event	4
No	**Scenario**	**Symbol**	**Weight**
1	Supply Side	SS	5
2	Demand Side	DS	5

Source: Own elaborated (2021).

Results of MULTIPOL Analysis

Table 2 presents the results of the MULTIPOL analysis based on the scores for each policy and the mean scores, as well as the standard deviations obtained.

Table 2. Evaluation Based on Action and Policy on Development of Custom villages as Digital-Based Tourism Villages

Actions	Policy		Mean Value	Std. Devia-tion	Position
	Tourism Village	Tourism Digital			
tour.obj	13.2	12.3	12.8	0.5	8
vil.infra	12.5	12.2	12.4	0.2	5
ict	12.2	13.2	12.6	0.5	7
msme	11.7	12.2	11.9	0.3	4
tour.skill	12.7	12.5	12.6	0.1	6
empowerment	7.9	9.3	8.5	0.7	2
mitigation	6.5	6.6	6.6	0.1	1
digi.liter	11.8	12	11.9	0.1	3

Source: Output the results of data analysis with MULTIPOL (2021).

As shown in Table 2, the highest scores were obtained in the arrangement of tourist objects/attractions, development and improvement of information network, and increasing community skills in tourism. The program for increasing community knowledge in disaster mitigation is in the last position, where this is because disaster mitigation related to the COVID-19 pandemic is considered only as a support for tourism village activities and digital villages.

Furthermore, Figure 2 presents the results of the MULTIPOL profile map that links the scores for each action with the policy.

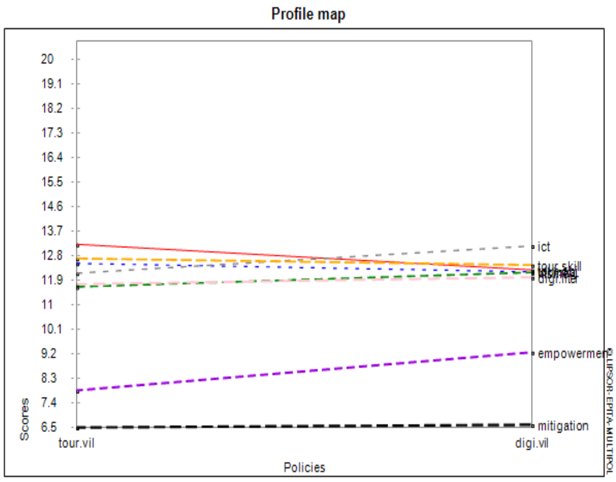

Fig. 2. Profile Map Between Actions and Policy
Source: Output the results of data analysis with MULTIPOL (2021).

As shown in Figure 2, the arrangement of tourist objects/attractions program excels in the tourism village policy. So, it can be said that the priority program that should be implemented for tourism village policies is the arrangement of tourist objects, considering that tourist villages should have tourist attractions as icons. Meanwhile, the digital village policy shows that the development and improvement of information network program is a program with a higher score than other programs. This is natural because to realize a digital village, of course, it is necessary to develop and improve information networks (information, communication, and telecommunication).

Furthermore, Table 3 for each policy against a predetermined scenario, namely the supply side and the demand side.

In more detail, Figure 3 presents the position of each policy against the scenario as the results are presented in Table 3.

Table 3. Policy Score Against Scenario

Policies	Scenario		Mean Value	Std. Devia-tion	Position
	Supply Side	Demand Side			
Tourism village	14.4	13	13.7	0.7	1
Digital village	15.1	13.6	14.3	0.7	2

Source: Output the results of data analysis with MULTIPOL (2021).

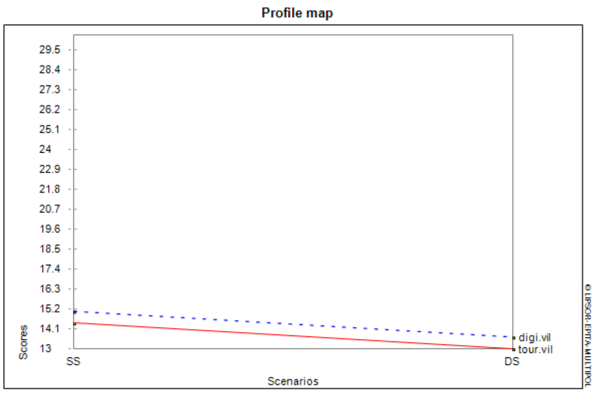

Fig. 3. Profile Map for Policy Against Scenarios
Source: Output the results of data analysis with MULTIPOL (2021).

Based on Table 3 and Figure 3, it is clear that the digital village policy excels in both supply side and demand side scenarios. This shows that digital village policies need to be considered as a priority for the sustainability of the development of Custom villages as digital-based tourism villages. However, the development of ICT is very rapid and has become one of the determinants of the success of the management, promotion, and implementation of tourist villages. MULTIPOL can be an alternative or complementary in sustainability analysis, especially those related to future analysis or foreseight [4].
The overall results of the MULTIPOL analysis can be presented in the form of a potential policy path as shown in Figure 4.

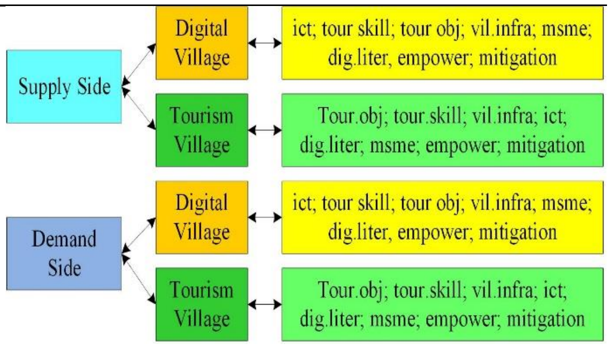

Fig. 4. Potential Policy Path
Source: Output the results of data analysis with MULTIPOL (2021) (elaborated).

Figure 4 presents the potential policy paths that can be taken through various actions that are in accordance with tourism village policies and digital villages, both in supply side and demand side scenarios. The role of the use of digital technology is allegedly going to be even greater in the new normal era, considering that people are accustomed to using ICT technology during restrictions during a pandemic. So, it is very natural that digital village policies will be further developed, including one of them being integrated with tourist villages.

CONCLUSIONS

In the development of custom villages into digital-based tourism villages that can adapt to the new normal era, the policies that can be carried out are tourism village policies and digital villages. In the tourism village policy, the program arrangement of tourist objects/attractions is a priority. Meanwhile, in digital village policies, development and improvement of information network programs are important. However, in the supply side and demand side scenarios, digital village policies become a priority. This is considering that in the new normal era, the use of ICT will be very large in various forms of community activities, including tourism.
As a follow-up, the results of this study can be used as a policy reference and can be used as a basis for conducting further research on other policies in the development of tourist villages, especially in the case of custom villages in Bali.

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MONITORING THE IMPACT OF INTENSIFICATION OF AGRICULTURAL LAND USE ON THE QUALITY OF SOILS OF UKRAINE

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Abstract

The article examines the influence of intensification of agricultural activities on soil quality, the dependence of humus content in soils on the dynamics of the technically available energy potential of crops grown in Ukraine in the regional context, as well as amount of organic fertilizers that can obtain from farm animal. A decrease in the humus content in the soils of Ukraine was established according to the obtained results. It is primarily due to increasing cultivation of soil-depleting crops and reducing the number of farm animals, waste products of which can use to restore land fertility. This situation leads to a loss of natural fertility of agricultural land and a decrease in their monetary value. It will require significant financial costs to further restore the quality characteristics of Ukraine's soils. The paper used a wide range of methods of statistical analysis, grouped administrative regions into clusters according to the study. Research data reveal a high correlation coefficient of the studied indicators within individual territories. The research results are expected to be used to plan the necessary measures to increase the environmental and economic efficiency of the agricultural land use system.

Key words*: *humus level, intensification, energy potential, organic fertilizers, soil quality

INTRODUCTION

Today, world agricultural production is focused on making a quick profit, despite the effects of anthropogenic impact on the state of the land. First of all, it is manifested in the intensification of the crop sector, which is focused on increasing the sown area under energy crops. This situation is typical for Ukraine too and aims to increase the crop industry's energy potential. Therefore, many scientific publications are devoted to the study of the peculiarities of growing energy crops used for bioenergy production, and their impact on soil fertility. Many scientists around the world are studying the aftereffects of energy crop production on the condition of land used in agriculture.

Thus, in particular, the study of the impact of different energy crops on the condition of soils and the possibilities of their cultivation on individual land plots are devoted to the works of many scientists [11, 13, 14].

Numerous works are devoted to methodological approaches to assessing the potential of energy crops for energy production and social and economic effects [8, 9, 17].

It is important to study [1, 16] in terms of improving the efficiency of economic instruments to reduce the negative human impact on the environment due to the use of products of energy crops. The findings of these studies confirm the importance of developing of the bioenergy industry to achieve positive economic and social results. However, it is defined that due to the increase in sown areas of soil-depleting crops there is an increase in the negative impact of

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economic activity on the quality parameters of land used in agriculture.

To restore soil fertility, the use of organic fertilizers to fertilize the land and restore the content of humus in the soil plays an important role.

The work of many scientists is devoted to the study of the use of organic fertilizers to improve soil fertility and obtain other environmental effects. Thus, in a study [12] it was substantiated that the introduction of animal manure into the soil promotes plant development, the resistance of herbivores, and the suppression of pests. The need for simultaneous intensive development of the livestock and crop industries to increase soil fertility has been proven in [7].

Practices of organic fertilizer production and soil quality improvement, as well as the relationship between the use of nitrogen and carbon in agricultural activities depending on the organization of waste management of animal and plant origin are widely represented in the study [2].

The practice of the organic fertilizer distribution(manure) depending on the quality characteristics of land and opportunities for the intensification of agricultural activities is studied in [5]. The importance of using manure to intensify the cultivation of crops is emphasized in a study on household development in China [6].

At the same time, the scientific community pays insufficient attention to a comprehensive study of the impact of intensification of crop production (including increased production of soil-depleting crops such as sunflower, soybeans, rapeseed, etc.) and the level of fertilization of land with organic fertilizers from farm animals (the content of humus in them).

Therefore, we hypothesize that there is a close relationship between these parameters to use the identified interdependencies to harmonize environmental and economic interests in the field of agricultural land use at different levels of government.

MATERIALS AND METHODS

The methodological basis of the study is a dialectical approach that allows assessing the effect of economic laws in establishing trends and patterns of social and natural phenomena and processes, to analyze the current state of the agricultural land use system, and suggest ways to improve it.

Important in the system of land-use efficiency assessment is a regionally integrated approach, which allows showing the interdependence of economic and social systems, their inseparable unity with the natural environment, the balance of relations with which forms the principles of environmental safety and sustainable development of land use in agriculture.

In this case, we consider it is important to use the cluster approach as a tool for targeted management of environmental and economic components of the regional system of land use in the agricultural sector. This is crucial in improving the environmental and economic efficiency of agricultural land use. Using the possibilities of clustering, it is assumed to identify areas where there is a significant effect of certain factors. The result is the establishment of priorities for economic development, taking into account its impact on the quality parameters of land.

To assess the level of intensification of land use in the agricultural sector, a study of the dynamics of the technically available energy potential of crops grown in Ukraine in the regional context. In this case, it is proposed to use the "Methods of generalized assessment of technically achievable energy potential of biomass", which was developed by scientists of the National University of Life and Environmental Sciences of Ukraine, Institute of Technical Thermophysics NAS of Ukraine, Institute of Renewable Energy NAS of Ukraine [4].

To determine the possibilities for the fertile layer restoration of soil (humus), which is lost because of growing crops during the analyzed period, it is suggested to investigate the production of organic fertilizers in the process of growing farm animals. The calculation is proposed to be carried out by following the "Methods for calculating the volume of agricultural products at constant prices and the index of agricultural products", which was approved by the order of the State Statistics Service of Ukraine from 19.09.2019 №311 [10].

The results of the research and the impact of the analyzed factors on the level of humus in the soils of Ukraine for the period 1990-2019 were evaluated using the software package Statistica 10.0: the degree of the interrelation of the analyzed indicators was assessed, influence, the clustering of the regions of Ukraine by the degree of interconnection, the unification of the regions into four clusters by the three assessed components.

The information base for the study was materials and reports of the State Statistics Service of Ukraine, the Institute of Soil Protection of Ukraine, guidelines for research of scientific, educational, and government agencies, publications of domestic and foreign scientists, as well as author's work on the issue.

RESULTS AND DISCUSSIONS

Deterioration of the ecological condition of land in the process of its agricultural use is an urgent problem in the modern world. This trend we can also observe in Ukraine. This is confirmed by the following study [15], in which the authors highlight the importance of taking into account environmental factors (level of land plowing, environmental stability, land pollution, development of degradation processes, etc.) in the process of organizing efficient agricultural land-use.

The article displays that the identification of environmental threats and risks will allow modeling measures to combat the impact of eco-destructive factors and form a mechanism for their implementation. This will have a positive impact on the state of agricultural land-use. Therefore, to identify eco-destructive factors in the system of agricultural land use, we propose to investigate the impact on soil quality of land use intensification in agriculture (by assessing the technically available energy potential obtained by growing crops in Ukraine), as well as to assess volumes of production of organic fertilizers in the process of growing farm animals. The results you can use to determine the possibility of restoring the humus content in soils.

According to the analysis of soil quality indicators by organic component (humus content) revealed a gradual decrease in the level of humus for the period 1990-2019. The dynamics of reducing the humus content on agricultural lands is noted in the following administrative regions of Ukraine: Cherkasy, Chernivtsi, Kharkiv, Khmelnitskyi, Luhansk, Mykolaiv, Poltava, Ternopil, Vinnytsia, Volyn. Thus, over the past 25 years, the average humus content in Ukraine has decreased by 0.12 percent. This is a significant loss because of increasing it in the soil for 0.1 percent in natural conditions requires 25-30 years [3].

Among the factors that caused this deterioration of soil quality is the impact of agricultural intensification activities. This process is accompanied by an increase in the structure of sown areas of those crops whose products can be used for bioenergy production and which in the process of development mineralize much more humus in the soil than the remaining organic matter after harvest (it is then used to fertilize land by its plowing).

The increase in the share of soil-depleting crops per 100 hectares of arable land is also evidenced by the growth of technically achievable energy potential of cultivated crops (Table 1).

In some regions (Zaporizhia, Herson, and Chernihiv regions) the growth occurred more than 10 times.

The situation is complicated by the fact that during the analyzed period in Ukraine, there was also a significant reduction in the number of farm animals. This has reduced the production of manure, which you can use to restore the humus content in the soil.

Table 1. Volumes of technically achievable energy potential per 100 hectares of arable land, which can be obtained from agricultural raw materials produced in Ukraine in the regional context for 1990-2019 (tons of conventional fuel per 100 hectares of arable land)

Region	Years								
	1990	**2000**	**2010**	**2012**	**2014**	**2016**	**2017**	**2019**	**2019/ 1990,%**
Cherkasy	4.2	1.8	6.4	9.9	10.2	9.2	7.8	12.6	300.0
Chernihiv	1.1	0.7	3.6	7.2	8.3	6.6	9.6	11.4	1,036.4
Chernivtsi	4.6	2.8	4.6	5.7	8.2	4.1	6.1	6.9	150.0
Dnipropetrovsk	0.9	0.9	1.9	1.4	3.3	3.3	4.0	7.7	855.6
Donetsk	0.4	0.4	0.5	0.5	1.2	0.6	1.5	2.2	550.0
Herson	0.4	0.3	3.1	0.8	2.4	1.9	3.7	5.3	1,325.0
Ivano-Frankivsk	2.6	1.7	3.2	8.0	11.7	8.6	13.1	10.4	400.0
Kharkiv	1.7	0.9	1.0	2.5	3.8	3.4	3.0	2.9	170.6
Khmelnytskyi	3.9	1.6	6.2	8.6	13.1	8.2	10.7	13.6	348.7
Kirovohrad	2.1	1.0	4.7	3.7	6.0	5.4	5.1	7.9	376.2
Kyiv	2.9	1.4	3.8	8.0	9.4	6.7	6.9	11.7	403.4
Luhansk	0.3	0.4	0.3	0.7	0.9	0.8	0.5	0.7	233.3
Lviv	2.9	1.4	6.8	9.3	11.7	8.8	12.2	13.2	455.2
Mykolayiv	0.8	0.3	3.4	1.1	3.2	1.4	2.5	5.8	725.0
Odesa	0.9	0.6	6.3	1.2	6.1	2.5	6.2	8.7	966.7
Poltava	3.3	1.3	4.3	6.5	7.3	8.7	6.5	9.4	284.8
Rivne	3.3	1.1	4.6	6.6	7.7	5.0	7.1	10.9	330.3
Sumy	2.9	0.8	3.1	6.4	8.9	7.0	7.9	9.7	334.5
Ternopil	4.5	2.2	8.0	10.5	14.1	9.8	12.8	15.8	351.1
Transcarpathian	1.6	1.6	2.8	3.2	3.2	4.4	4.2	4.3	268.8
Vinnytsia	4.1	2.3	5.6	7.5	12.4	8.6	10.8	13.4	326.8
Volyn	2.3	1.0	3.6	5.1	7.4	4.8	8.4	12.4	539.1
Zaporizhia	0.3	0.3	1.4	0.4	1.2	1.2	1.5	3.9	1,300.0
Zhytomyr	1.2	0.5	2.5	5.6	6.5	4.8	6.4	10.4	866.7
Ukraine	**1.9**	**1.0**	**3.5**	**4.2**	**6.1**	**4.6**	**5.7**	**8.0**	**421.1**

Source: calculated according to the State Statistics Service of Ukraine.

Thus, the volume of production of organic fertilizers per 1 ha of arable land decreased the most in Luhansk, Mykolaiv, and Zaporizhia regions - in the range of 9.7-16.5 times (Table 2).

To establish the interdependence between the indicators of the obtained technically achievable energy potential of crops per 100 hectares of arable land and the level of humus in soils, we studied the correlation dependence of the dynamics of these indicators in terms of regions of Ukraine.

As a result of the analysis, the regions where there is the closest connection of these indicators (correlation coefficient greater than 0.8) were identified. Thus, the greatest direct connection is observed between the dynamics of indicators of technically achievable potential of agricultural sowing and the level of humus in the following regions: Transcarpathian (0.88) and Kyiv (0.86) regions. We note the inverse connection in Luhansk (-0.83), and Kharkiv (-0.85) regions. This is evidence of the intensification of agricultural activities in these administrative areas.

The interdependence of humus content in soils on the dynamics of organic fertilizer production is greatest in the following regions: Khmelnytskyi (0.92), Lviv (0.90), Mykolaiv (0.92), Poltava (0.97), Vinnytsia (0.88) and Volyn (0.98), region. The closeness of the connection of these indicators in Ukraine, in general, is also quite significant (the correlation coefficient is 0.98).

The inverse connection between these indicators is noted in the Chernihiv region (-0.98). The explanation for this may be a significant increase in sown areas of depleting crops (sunflower and soybeans) with a significant reduction in the application of organic fertilizers to improve the quality of land (in this region, they are characterized by low humus content).

Table 2. Volumes of organic fertilizers per 1 ha of arable land that can be obtained from farm animals in terms of regions of Ukraine, t per 1 ha of arable land

Region	Years								
	1990	**2000**	**2010**	**2012**	**2014**	**2016**	**2017**	**2019**	2019/1990,%
Cherkasy	7.7	3.5	2.4	2.4	2.2	2.0	1.9	1.8	23.4
Chernihiv	9.9	3.6	1.9	1.9	1.6	1.5	1.4	1.2	12.1
Chernivtsi	13.5	6.1	4.2	4.1	3.5	3.2	3.1	3.0	22.2
Dnipropetrovsk	6.2	1.8	1.1	1.1	1.1	1.0	0.9	0.9	14.5
Donetsk	6.7	2.1	1.4	1.4	1.0	0.7	0.8	0.8	11.9
Herson	5.4	1.4	0.8	0.9	0.9	0.8	0.7	0.6	11.1
Ivano-Frankivsk	14.1	8.1	5.5	5.6	5.2	4.8	4.5	4.2	29.8
Kharkiv	6.6	2.4	1.2	1.2	1.2	1.1	1.1	1.0	15.2
Khmelnytskyi	9.0	4.5	2.4	2.4	2.2	2.1	2.1	2.0	22.2
Kirovohrad	5.1	1.5	0.9	0.9	0.8	0.7	0.7	0.6	11.8
Kyiv	9.5	3.4	1.9	2.0	1.9	1.8	1.8	1.8	18.9
Luhansk	6.6	1.8	1.1	1.0	0.6	0.4	0.4	0.4	6.1
Lviv	13.7	7.5	4.0	4.0	3.6	3.4	3.3	2.9	21.2
Mykolayiv	4.9	1.4	0.9	0.9	0.8	0.8	0.9	0.5	10.2
Odesa	5.6	2.3	1.3	1.3	1.3	1.1	1.0	0.9	16.1
Poltava	7.3	2.8	1.6	1.7	1.6	1.5	1.4	1.3	17.8
Rivne	12.2	5.8	3.7	3.8	3.3	3.0	2.9	2.4	19.7
Sumy	7.8	3.4	1.5	1.5	1.3	1.3	1.3	1.2	15.4
Ternopil	10.3	4.6	2.6	2.8	2.5	2.4	2.2	2.1	20.4
Transcarpathian	18.9	10.3	9.0	9.2	8.6	8.0	7.7	8.0	42.3
Vinnytsia	7.4	3.4	2.1	2.2	2.1	2.2	2.1	1.8	24.3
Volyn	13.7	6.1	4.0	4.1	3.6	3.4	3.2	2.8	20.4
Zaporizhia	5.8	1.5	0.8	0.8	0.8	0.7	0.7	0.6	10.3
Zhytomyr	10.0	4.8	2.3	2.3	1.9	1.9	1.9	1.9	19.0
Ukraine	**7.4**	**2.9**	**1.7**	**1.7**	**1.5**	**1.5**	**1.4**	**1.3**	**17.6**

Source: calculated according to the State Statistics Service of Ukraine.

The cluster analysis of the regions of Ukraine was carried out in the program Statistica 10.0. In each of the clusters for the period, 1990-2019 (data for 1990, 2000, 2010, and 2019 were used for the study) similar properties of the following indicators were taken into account: the volume of the technically achievable energy potential of cultivated crops, the volume of production of organic fertilizers and the content of humus in the soil. The results of cluster analysis in the division of regions of Ukraine into 4 clusters are given in Tables 3 and 4.

Table 3. The results of the cluster analysis of the regions of Ukraine for 1990, 2000, 2010, and 2019 are based on the grouping of the studied indicators that affect the quality of soils

Years	Cluster characteristics (administrative areas)			
	First	Second	Third	Fourth
1990	Chernivtsi, Ivano-Frankivsk, Lviv, Rivne, Transcarpathian, Volyn	Cherkasy, Chernihiv, Khmelnytskyi, Kyiv, Poltava, Sumy, Ternopil, Vinnytsia, Zhytomyr	Dnipropetrovsk, Donetsk, Kharkiv, Luhansk	Herson, Kirovohrad, Mykolayiv, Odesa, Zaporizhia,
2000	Cherkasy, Chernihiv, Khmelnytskyi, Kyiv, Poltava, Sumy, Ternopil, Vinnytsia, Zhytomyr	Chernivtsi, Ivano-Frankivsk, Lviv, Rivne, Transcarpathian, Volyn	Herson, Kirovohrad, Mykolayiv, Odesa, Zaporizhia	Dnipropetrovsk, Donetsk, Kharkiv, Luhansk
2010	Chernihiv, Herson, Kirovohrad, Kyiv, Mykolayiv, Poltava, Sumy, Zhytomyr	Dnipropetrovsk, Donetsk, Kharkiv, Luhansk, Zaporizhia	Cherkasy, Khmelnytskyi, Lviv, Odesa, Ternopil, Vinnytsia	Chernivtsi, Ivano-Frankivsk, Rivne, Transcarpathian, Volyn
2019	Chernivtsi, Dnipropetrovsk, Herson, Kirovohrad, Mykolayiv, Odessa, Poltava, Sumy	Cherkasy, Chernihiv, Ivano-Frankivsk, Khmelnytskyi, Kyiv, Lviv, Rivne, Ternopil, Vinnytsia, Volyn, Zhytomyr	Transcarpathian	Donetsk, Kharkiv, Luhansk, Zaporizhia

Source: calculated by the authors.

Table 4. Average values of quantitative indicators of the volume of the technically achievable energy potential of crops, organic fertilizers, and humus content according to the results of cluster analysis of the regions of Ukraine in 1990, 2000, 2010, and 2019 based on the grouping of studied indicators that affect the quality status soils

Name quantitative indicators	Numerical characteristics of clusters (average values of quantitative indicators (standard deviations))			
	First	Second	Third	Fourth
1990 year				
Organics	14.35 (2.32)	8.77 (1.22)	6.53 (0.22)	5.36 (0.36)
Potential	2.88 (1.02)	3.12 (1.25)	0.83 (0.64)	0.9 (0.72)
Humus	2.34 (0.42)	2.92 (0.53)	4.18 (0.29)	3.33 (0.73)
2000 year				
Organics	3.78 (0.68)	7.32 (1.72)	1.65 (0.44)	1.92 (0.34)
Potential	1.40 (0.64)	1.60 (0.65)	0.38 (0.15)	0.72 (0.29)
Humus	2.84 (0.49)	2.38 (0.58)	3.01 (0.58)	4.14 (0.21)
2010 year				
Organics	1.48 (0.56)	1.12 (0.22)	2.47 (0.88)	5.28 (2.19)
Potential	3.56 (0.70)	1.02 (0.65)	6.55 (0.81)	3.76 (0.82)
Humus	2.97 (0.70)	3.99 (0.37)	2.98 (0.29)	2.33 (0.54)
2019 year				
Organics	1.13 (0.81)	2.26 (0.80)	8.00 (0.00)	0.7 (0.26)
Potential	7.68 (1.60)	12.35 (1.62)	4.30 (0.00)	2.43 (1.35)
Humus	3.32 (0.70)	2.68 (0.53)	2.56 (0.00)	3.69 (0.32)

Source: calculated by the authors.

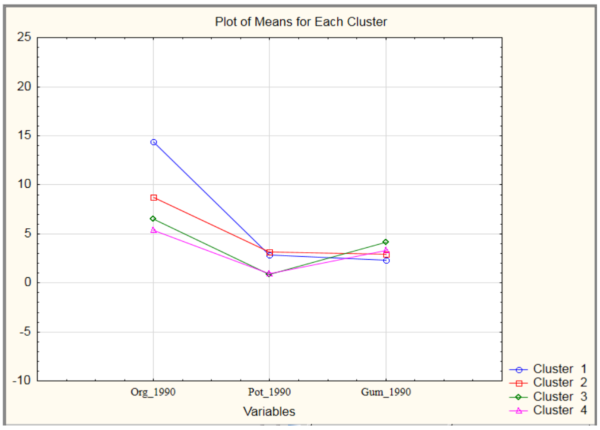

Fig. 1. Graphic representation of averages for each cluster in 1990

Source: calculated by the authors.

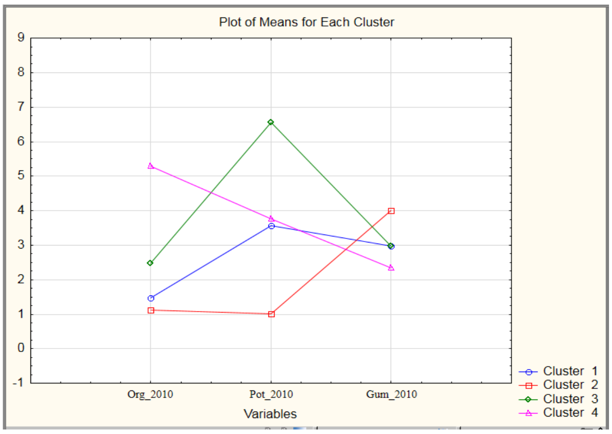

Fig. 3. Graphic representation of averages for each cluster in 2010

Source: calculated by the authors.

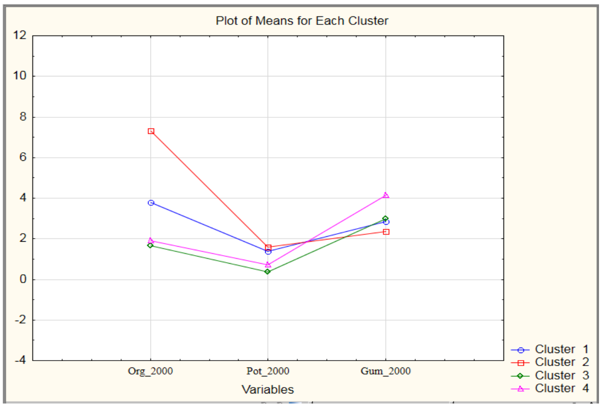

Fig. 2. Graphic representation of averages for each cluster in 2000

Source: calculated by the authors.

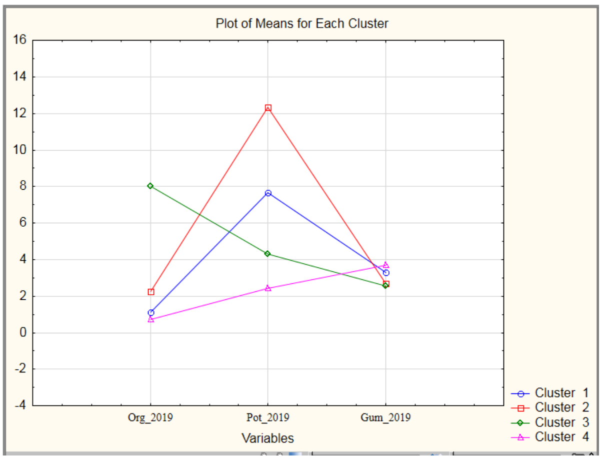

Fig. 4. Graphic representation of averages for each cluster in 2019

Source: calculated by the authors.

The correct choice of the number of clusters is confirmed by analysis of variance because at the level of significance $p < 0.05$ we have differences between the obtained groups.

In fig. 1-4 shows the results of cluster analysis (C-average method) in some years for the period 1990-2019 in the form of division of regions into four clusters by three components (the amount of technically achievable energy potential of crops, the amount of organic fertilizers and the level of humus in soils).

Based on the presented figures, we observe the relationship between the studied groups of indicators. Thus, during the analyzed period in all clusters the highest average indicators for the production of organic fertilizers (manure) and technically achievable energy potential of crops correspond to one of the lowest average indicators of humus content in soils, and vice versa. This may indicate limited use of organic matter to improve soil quality, as well as an increased intensification of agricultural activities. The consequence is the depletion of agricultural land. In addition, in 2010-2019, we note a significant increase in the volume of technically achievable energy potential in the 3rd and 2nd clusters. It indicates an increase in the production of energy-intensive agricultural products, especially in the administrative regions, which are located in the West, North, and centre of Ukraine, and affects the quality of soils (humus content) in these regions.

According to the results of the study, it should be noted that in most regions of Ukraine there is an inverse connection between the humus content in soils and the intensification of agricultural land use. This determines the relevance of further balancing the anthropogenic impact on the state of land and determining the directions of development of agricultural land use. They will be aimed at taking into account the dynamics of humus content in soils in the process of optimizing the structure of sown areas of crops and the formation of an appropriate system of organic fertilizers. To ensure of balanced use land at the national level, it is crucial to form a set of legislative acts that will be aimed at exercising appropriate administrative influence on land users, whose actions lead to the deterioration of the quality of agricultural land.

Therefore, it is important to increase soil fertility to organize a system of balanced land use, aimed at improving the efficiency of agricultural land use.

CONCLUSIONS

The study makes it possible to argue that the monitoring and consideration of the interaction of the two subsystems of natural and economic on the quality of land is crucial for the formation of a system of balanced agricultural land use. The analysis installed the relationship between the intensification of agricultural activities, the level of production of organic fertilizers, and the quality of land (humus content in soils).

Using the data of statistical processing in the program Statistica 10.0 of the studied indicators, a significant level of interdependence and clustering of the regions of Ukraine in the period 1990-2019 was revealed.

Further study of the impact of regulatory factors of a balanced natural economic system will identify positive measures to improve soil fertility and reduce the impact of negative anthropogenic factors on the quality parameters of agricultural land.

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