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STUDY ON THE NEW MANAGEMENT STRATEGY FOR AGRICULTURAL FARMS IN ROMANIA, AS A RESULT OF THE ENERGY CRISIS FROM 2021-2022

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Abstract

In Romania, in 2020-2022, a series of events took place which led to the need to rethink and adapt the management of agricultural farms to the new conditions. It is about the health crisis caused by the Covid-19 pandemic, which overlapped with one of the driest agricultural years (2019-2020), but also about the energy crisis, that for agriculture meant the unprecedented price increase for inputs and technologies. Under these conditions, the cost of food has increased from the very first stage of the production process, namely obtaining the raw material. Analyzing the data provided by the Romanian Commodities Exchange, the upward trend in prices starting with January 2020 and lasted until February 2022 can be observed. For the main crops in Romania, namely wheat, corn and sunflower, trading prices increased with 26-73%. At the same time, there are significant increases in inputs, which in turn are caused by higher prices in the energy sector – 443% for natural gas and 194% for electricity. Petroleum products were no exception, with a doubling of the price between the beginning of 2020 and February 2022. All these have led farmers to look for new solutions in order to ensure, at least partially, the necessary fertilizers from natural sources, through crops that are able to bring nitrogen into the soil. Reducing costs per hectare by introducing legumes (especially soy) into crop rotation and merging technological works are only the first proposed solutions, and in the coming years more innovations will be implemented in agricultural management.

Key words**:** *energy crisis, inputs, yields, technologies, agricultural management*

INTRODUCTION

Agricultural production has been and will continue to be dependent on a number of basic inputs, such as soil, labor, capital and technology. Of these, the soil is the most limited resource, because of the anthropogenic activities the fertile areas being constantly decreasing [5].

Despite all the progress made in this domain, there are still many farmers in Romania without technical knowledge, who don't use agricultural management tools and who don't know how to orient themselves to the market [6]. Due to the lack of technologies, most small farmers obtain minimum yields, being on the verge of subsistence [2].

On the other hand, [15] states that in the United States the main raw material of modern agriculture is fossil fuel, the labor force being relatively low. The study highlighted that as fuel prices increase, production costs will automatically increase, noting that a yield of 2.8 kcal of corn per 1 kcal of used fuel may be uneconomical.

Worldwide, in the period 2000-2018, the total index of food prices increased by about 121%, and specifically by 108% for cereals and 72.8% for meat [20].

Incrising food prices have been translated into concerns about food security and food accessibility for a large number of people.

Current statistics show that obtaining agricultural production consumes about 70% of freshwater resources and 25-30% of energy currently available on Earth. All agricultural activities are consuming energy – germination bed preparation, sowing, fertilizing, treatments, harvesting, processing, storage and sale [9].

Finding new ways to optimize the activities carried out in agriculture, to obtain food, has

strong implications in the agricultural field and related economic branches, which can lead to reduced costs, increased income and/or increased average yields [21].
With the modernization of industry and agriculture, energy consumption has also increased (Figure 1). This massive technology, based of which record yields were obtained, was considered the best element of sustainable development. Then, against the background of environmental protection, integrated agriculture has improved energy efficiency by reducing energy input without affecting production [11].

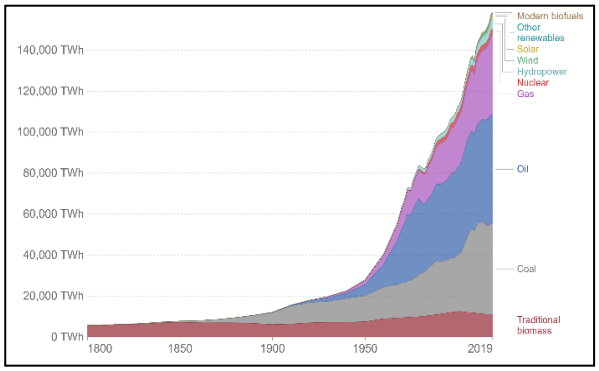

Fig. 1. The evolution over time of energy consumption and the quantities related to each type
Source: [17].

From the point of view of energy consumption, the most demanding activities in the entire food production and distribution system include [8]:
-chemical production of fertilizers and plant protection products;
-production of machinery and equipment necessary for food processing;
-mechanical works in the field;
-transport of products;
-industrial food processing.
It's becoming obvious that agricultural production is sensitive to changes in energy prices, either through direct consumption or through inputs that cannot be eliminated, and here the main category is fertilizers. In addition, measures taken to limit climate change, by taxing emissions, lead to increases in energy prices [19], whether it's about natural gas, electricity or fuel.
On the other hand, the agricultural sector can be a source of renewable energy, such as biomass or biofuels, and by using sustainable energy sources can help reduce the impact on the environment [16].
Where this isn't done, for various reasons, the negative effects of the energy crisis on the well-being of farmers, especially small and medium-sized ones, with limited resources, have already been reported [1, 10, 12, 13]. The four main crops, which account for 70% of world food production, are rice, wheat, corn and soybeans. Of these, rice production requires the most energy, especially through irrigation. At the other end of the spectrum are soybeans and legumes (peas, chickpeas etc.), which have the ability to fix nitrogen directly from the atmosphere, requiring a smaller amount of synthetic fertilizers [4, 18].
The aim of this paper is to present the main sources of energy that are found in nature and that can be accessed through various agricultural practices, especially as the price of conventional energy (fossils) continues to rise, causing food production to involve increasing costs.

MATERIALS AND METHODS

Considering the changes we feel at the economic level, we structured the economic analysis on three of the basic crops in Romania – wheat, corn and sunflower. In line with them, we followed the dynamics of prices for natural gas and electricity. For data collection we accessed the online platforms of the National Institute of Statistics (NIS, Tempo-online database), Romanian Commodity Exchange (BRM) and the National Energy Regulatory Authority (ANRE).
Based on the obtained results, we performed an analysis of the costs involved in agrotechnical works, to see which are the technological links where changes can be made. We also proposed a crop rotation to help the nitrogen fixation into the soil, which would also reduce input costs.

RESULTS AND DISCUSSIONS

The digital era, which began in the 1970s, has logarithmically led to the optimization of

economic processes, including agriculture. We point out that, now, almost all manufacturers of tractors and agricultural machinery have launched fully electronic tillage, sowing and maintenance equipment. The adjustment of the machines according to their technological parameters (density and depth of sowing, depth of application of fertilizers, doses of fertilizers and pesticides, speed of machines and combines according to the working conditions) is carried out automatically, computerized.

The energy used in the synthesis required by nitrogen fertilizers was represented by oil or gas, i.e. extremely polluting hydrocarbons, especially since they were forced to achieve reaction temperatures above 1,000°C. Soon, the so-called Green Revolution began to show its weaknesses. People had something to eat, but they could no longer breathe and they had no water to drink, as a result of the reaction shown schematically in Figure 2.

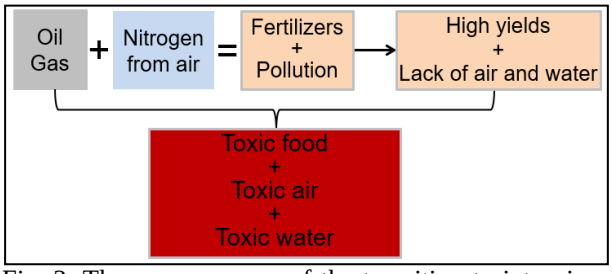

Fig. 2. The consequences of the transition to intensive agriculture – schematic presentation
Source: Original.

This leads to the Jevons Paradox, which states that "the advancement of technology increases the efficiency of the use of a resource, but nevertheless doesn't decrease the consumption of resources, but increases it" [22].

Taking into account the above, but also the overlap of other events, among which we mention the Covid-19 health pandemic, with all the imposed restrictions and limitations, the extreme drought of the agricultural year 2019-2020, followed by the liberalization of the energy market, started in 2021, but also by the armed conflict on Romania's borders, the rules began to change, and the economy was unbalanced on several fronts. Energy consumption increased significantly in the period 2020-2022, which generated additional costs in many sectors (Table 1).

Analyzing the data in the table, we find that the prices of unprocessed food had non-homogeneous increases, from 26% for maize, to 54% for wheat and 73% for sunflower. It is true that the dynamics of prices was accentuated especially at the end of 2021 and the beginning of 2022. We also note that previously, in the period 2016-2019, although there was an increasing trend, it was insignificant.

On the other hand, the years 2021 and 2022 were marked by unprecedented increases in natural gas (+443.55%) and electricity (+194.14%), all these additional costs will be reflected on the food market in the following months. From an agricultural point of view, the growth will be felt in the summer-autumn of 2022, when the yield of the current year will be marketed and when farmers will have to cover, from sales, the expenses made over the year with the establishment and maintenance of the crop.

Table 1. Average prices in agriculture and energy fields in 2016-2022 and their dynamics

Crop/ Energy	2016	2017	2018	2019	2020	2021	2022*	2022/ 2020
	lei/ton							(%)
Wheat	640	660	690	730	800	980	1230	153.75
Maize	760	690	730	740	830	920	1050	126.50
Sunflower	1,530	1,380	1,330	1,310	1,520	1,790	2,630	173.03
	lei/MWh							%
Natural gas	82	74	89	102	124	412	674	543.55
Electric energy	423	434	472	468	478	562	1,406	294.14

*average price for January and February 2022
Source: ANRE, BRM, NIS [3, 7, 14].

What can be done about it in the years to come? How can we make sure that the price of wheat, for example, is not going to increase 5 times, in order to keep up with all the other

inputs needed to obtain the yield? The answer seems to be as simple as possible, namely to look back at natural models and use them, based on the knowledge we have today.
Specifically, a first step is to comply with the technologies, first by avoiding crop rotations consisting of less than 4 crops, one of which is legumes (soybeans, peas, chickpeas etc.). Already in the regions of Romania with higher rainfall, experienced farmers have begun to grow soybeans on very large areas.
In Figure 3 we present a model of evolution of soil preparation works, starting from classical agriculture to the current one, minimally invasive and, in addition, much more economical.

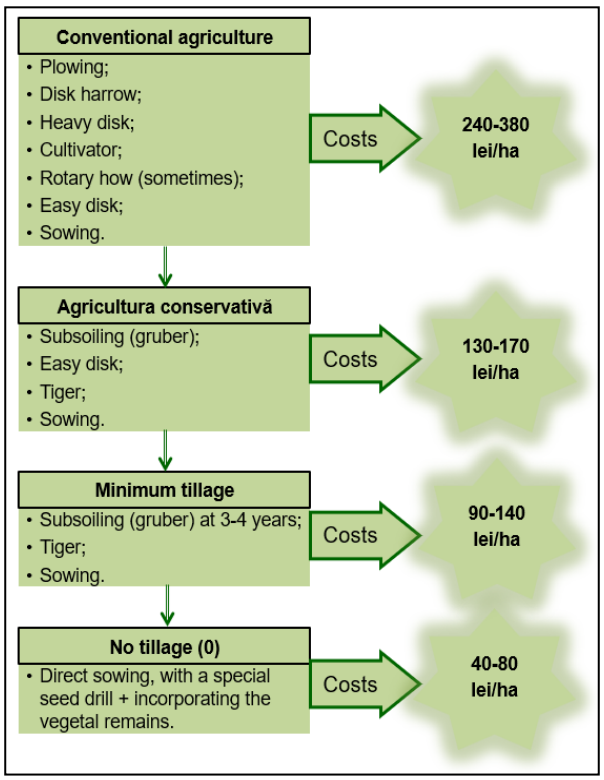

Fig. 3. The costs involved in the tillage specific to each type of agriculture
Source: Own calculation.

Thus, we see how we can save 200-300 lei/ha only by merging the soil works. However, in order to do this, it's necessary to prepare the soil in advance by incorporating the remains. Permanent ground cover is slowly but surely transforming the ecosystem into its original, natural form of existence, which will no longer require relocation (plowing) and, consequently, the conservation of humus and structure will be achieved naturally, correlated with the biological restoration of the soil.
The second step is concerning plant nutrition, which in the last 50 years has been influenced by chemical syntheses that have provided agriculture with large amounts of nitrogen taken from the air with an unnatural pattern (the Haber-Bosch process), which consumes a lot of energy, in the same time being a pollution generator. The synthesis of nitrogen fertilizers, doubled by the plant protection products (pesticides), has generated tremendous progress in food production, as well as in the demographic dynamics of the world – they have brought a certain food satiety to a good part of the world's population, but not a long-term safety of life.
If we think of a general index of comfort of human society according to the two models of development (natural vs intensive), for agriculture they could look like in Figure 4. It is not justified at all, from a logical point of view and human wisdom, to accept intensive model. Natural development would have led to the partial or even total avoidance of crises and would have ensured the sustainability of society.

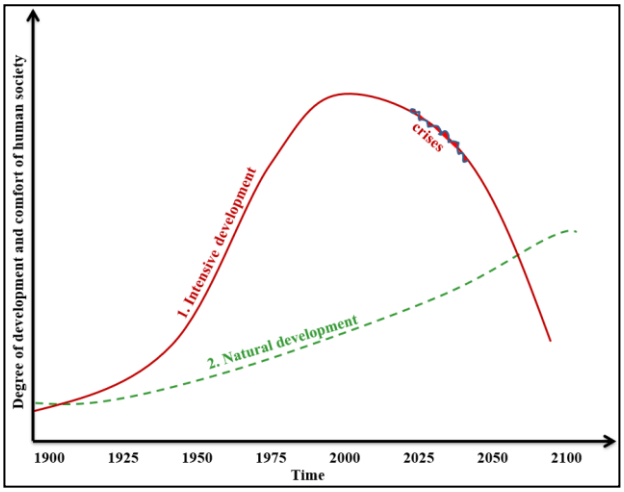

Fig. 4. The effect of agricultural development models on the comfort and well-being of human society
Source: Original.

Microorganisms are those small organisms that populate the Earth's ecosystems, which are extremely industrious and specialized, and which create, through biochemical reactions, products that no human synthetic technology could create. The biological fixation of

nitrogen by them is carried out according to very precise natural laws, genetically coordinated, but insufficiently known. The following 4 categories of nitrogen-fixing microorganisms (mainly species of bacteria) live in terrestrial ecosystems and especially in soil (Figure 5).

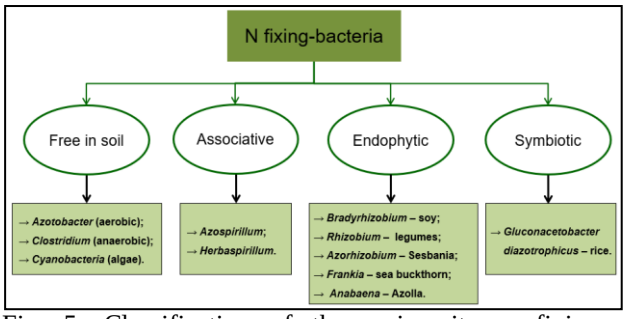

Fig. 5. Classification of the main nitrogen-fixing microorganisms (bacteria)
Source: Original.

The working model of associative bacteria is the following: starting with 4°C in the soil, the bacteria, very present, including in Romania, are close to the root zone. As the temperature rises, so does their hunger. They send chemical enzymatic signals to the plants, requesting food (elaborate photosynthesis products – glucose or glutamate). If there isn't enough nitrogen in the soil, then the plant accepts the collaboration with the bacteria and the association begins to work.

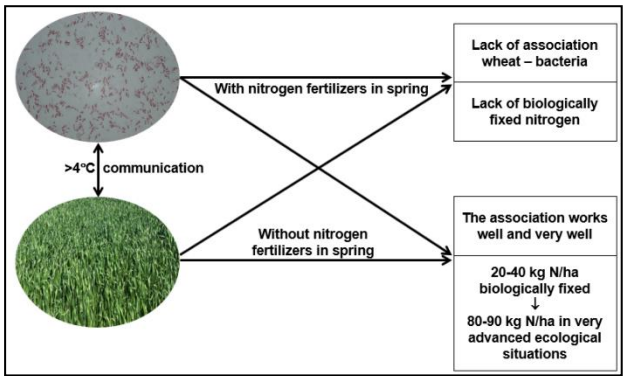

Fig. 6. Diagram of the association between *Azospirillum* and wheat
Source: Original.

The most numerous researches were done on wheat, where the association fixed, on average, 20-40 kg N/ha, with peaks of up to 90 kg N/ha. The application of chemical fertilizers with nitrogen in early spring interrupts the operation of the association, as the plant is an extremely economical system, which doesn't release energy in the form of glucose or glutamate if nitrogen is already in the soil (Figure 6).

CONCLUSIONS

Some of the technological processes currently in use will become impossible in the years to come, amid the impending economic crises. In order to be more cost-effective, but also to be able to achieve consistent long-term agricultural production, the management of the farm will have to take into account some basic criteria, which we can't neglect, although it clearly requires more effort than application of synthesis inputs:

-the most adapted crops for the respective region will be chosen, which will make the best use of the existing natural resources and will not assume the risks of the area (drought in soil and atmosphere, soil specificity, biotic and abiotic factors etc.);

-the crop rotations will not have less than 3 crops and will contain up to 25% breeding plants, such as perennial and annual legumes (alfalfa, clover, other fodder legumes, peas, soybeans, beans, chickpeas);

-maize, sunflower, cereals and oil crops will hold the remaining 75%;

-aggressive soil works (plowing, milling, disc, etc.) will not be allowed, which are high energy consuming – they will be replaced with non-aggressive works, on minimum or 0 tillage;

-green crops, consisting of grasses and legumes, will play a major role in protecting the soil, on the surface and inside it (as green organic fertilizers).

A good soil structure, obtained through reduced tillage, incorporation of straw and green manure, will lead to the elimination of waste of water, energy and other inputs. Thus, when the crop is established, the plants will find in the soil all the necessary conditions for their development in good conditions. Human intervention will be kept to a minimum, as well as the maintenance and fertilization works that will have to be carried out.

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