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TECHNOLOGY OF MECHANIZATION IN SUNFLOWER UNDER THE CONDITIONS OF IP, SĂLAJ COUNTY, ROMANIA

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Abstract

The purpose of this work relates to the study of sunflower on an area of 8 ha, carried out in the territory of Ip in Sălaj County, Romania, on the land of a family farm. The choice of aggregates is also based on direct operating expenditures. When carrying out works with different agricultural aggregates, one should always choose the optimal variant that is apreciated by the minimum amount of the number of aggregates taking part in the performance of the work or the minimum amount of time, i.e., after the consumption of fuel. Two types of tractors were used for the execution of mechanized works in sunflower: Tractor U 650 M and tractor FENDT FARMER 311 LSA. In order to obtain large and high-quality production in sunflower, fertilization is of particular importance. The soil fertiliser reserve must provide plants with nitrogen, phosphorus and potassium supply from the first days of vegetation. The doses of fertilisers to be administered vary depending on soil reserve, soil type and on other factors related to climate and soil. The factors that influenced sunflower production in 2019 were: climatic conditions, crop rotation, soil fertility, mechanical work quality, sowing time, and cultivated hybrid.

Key words: *production, Sălaj, sunflower, mecahnization technology*

INTRODUCTION

This work presents an analysis of the consumption and costs of mechanized works and materials used to optimize crop technology in sunflower [13, 5].

The studies in this paper were carried out under the conditions specific to the Şimleu Depression, belonging to the great geographical units of the West Hills. The territory taken in the study belongs to the Ip village in Sălaj County, and is representative for the Şimleu Depression [4]. The work aims to render the information existing in the literature on sunflower as concretely as possible, followed by information about the natural framework and our own results.

It should be noted that Romania is the largest producer of sunflower in the European Union, being ranked 5th globally (1.6 million t) after Ukraine, Russia, Argentina, and China. Also, with good management within the farms, sunflower can bring a much higher profit to agricultural holdings [9, 10].

At the moment, manufacturers capitalize on production, largely in the form of grains, in the domestic market and on export [7, 17].

For Romania, that has great agricultural potential through the area of land per capita and favourable pedoclimatic conditions, it is important to increase labour productivity by increasing the degree of mechanization in agricultural holdings [8]. Sunflower is the most important oleaginous plant cultivated in our country [13]. Romania is part of the great sunflower cultivators, being the first country in which sunflower hybrids have been introduced and cultivated. Sunflower has uses in human nutrition and animal feed, in industry and energy, plus a number of specific uses [13]. Sunflower is grown compulsory in long-lasting rotations in which the straw cereals (wheat) and maize predominate [3]. Given the peculiarities of sunflower (high water consumption and nutrients, attack by diseases, by sunflower broomrape attack), in most of them research recommends the cultivation of sunflower in rotations of 4 to 10 years [7].

In rotation, sunflower follows straw cereals, maize, peas, potatoes, oil linen, various fodder plants, silage maize, or green fodder. It should not be grown after sugar beet, alfalfa or monoculture (sunflower returns on the same soles after 5-6 years) [18]. When cultivating sunflower cultivars with high resistance to downy mildew and other diseases, the return interval on the same soles may be reduced to 4 years. In sunflower, no large productions can be obtained without proper fertilization [15,16]. The determination of the system of fertilization in sunflower is made according to the estimated production, to specific consumption, to natural soil fertility, to pre-emergent plant, to water reserve in spring at the beginning of vegetation, to the peculiarities of nutrition in sunflower [2, 11]. Sunflower is a plant with high requirements towards soil work. For sowing, the soil must be aerated in depth, without hardpan and without lumps on the surface, with a good porosity, without weeds, and well stocked with water in the shallow layer [1, 6, 14]. Only certified seed shall be used for the establishment of sunflower crops. The seed must have a purity of at least 98%, germination at least 85%, and uniformity in size and weight (calibrated) [10]. In sunflower, maintenance work begins before the plants sprout: harrowing the culture after sowing for the levelling of the land and crushing the crust and sprouting weeds, before sunrise with an adjustable coulter harrow or a rotative hoe. It is a work of great importance in sunflower [12, 20]. The time of the harvest in sunflower is linked to the maturity of inflorescence and the humidity of the seed. In uniform maturing hybrids, the humidity of the seeds can be appreciated by the colour of the capitulum [19].

MATERIALS AND METHODS

The studies in this paper were carried out on the territory of Ip in Sălaj County, Romania, from 2018 to 2019, on the land of a 35-ha family farm. Part the land of the farm is personal property (12 ha) and the rest is a lease from landlords (23 ha). The study refers to the culture of the sunflower.

The farm is equipped with the following machines: a FENDT FARMER-311 LSA tractor, a U-650M tractor, a 3-plough body reversible HUARD plough, a PP-4.30 plough, a GD-3.2M disc harrow, an EBRA 4.5 combiner, a CPPM-4 cultivator, a straw cereal STEGSTED STA 3M25RK seeder, a SPC 4 maize seeder with fertilization equipment, a NORDAGRI 500 solid chemical fertiliser machine, a WIRAX 400 portable herbicide machine, a tractor trailer, a John Deere 1052 grain harvester, and a SIP SEMPETER EKO 3500 maize harvester.

In the agricultural year 2018-2019, 8 ha were cultivated with sunflower, 10 ha with wheat, 10 ha with maize, 3 ha with triticale, and 4 ha with oat.

The main mechanized works in sunflower and the aggregates used were:

-Fertilisation: U-650M tractor + NORDAGRI 500 fertiliser machine;

-Ploughing: FENDT FARMER 311 LSA tractor + reversible HUARD plough;

-Soil preparation: FENDT FARMER 311 LSA tractor + EBRA 4.5 combiner;

-Sunflower sowing: U-650M tractor + SPC 4F seeder;

-Herbicide treatment: U-650M tractor + WIRAX 400 herbicide spreader;

-Weeding: U-650M tractor + CPPM-4 cultivator;

-Sunflower harvesting: JOHN DEERE 1052 combine + RFS equipment.

The types of tractors are chosen according to the technological process of the works and the biological properties of crops, following such indicators as ground clearance, gauge, outline dimensions, plot dimensions, energy consumption of machines, soil humidity, and the manoeuvrability of the aggregate.

The choice of aggregates is also based on direct operating expenditures. If two aggregates, after the cost of the works, require the same production costs, choose the one that satisfies the requirements of the machine system. The technical, technological and economic performance of agricultural aggregates is appreciated by the following techniques, also called indices of use or exploitation: working depth, working width, working speed, tensile strength, actuation power, working capacity, power source load, and fuel consumption. The mobile aggregate moves into work at a certain speed, which is determined by the agri-technical requirements imposed by the quality of the work and the possibilities of traction and actuation of the working machines in the aggregated. Actual working speed influences the quality of the work performed. In order to achieve quality work, it is necessary to observe a working speed, specific to each work, called technological speed. Any agricultural machine operated from the power outlet has established, by design and construction, the actual power necessary for the realization of the technological process at qualitative indices and appropriate productivity. Therefore, upon formation of aggregates, the power available at the tractor power outlet should be greater than 5 ÷ 15% than the actual power necessary for the operation of the working bodies of the agricultural machine.

Working capacity of agricultural aggregates

The theoretical working capacity of aggregates may be determined by working time (W_h^t) or on the exchange of work (W_{sch}^t) and shall be calculated, taking into account the theoretical breadth B, the theoretical working speed v_t, and the time of an exchange T_s, with the help of relations:

The actual working capacity is the amount of work that an aggregate that has the actual width B_l (m) and moves with the working speed v_l (km/h) during the actual time of an hour T_l or exchange T_{ls} (h), respectively:

RESULTS AND DISCUSSIONS

Two fertilization works were carried out on the land cultivated with sunflower:

-Basic fertilization with complex NPK fertilisers (4:12:12) – 200 kg/ha;

-Sowing fertiliser with complex NPK fertilizers (16:16:16) – 200 kg/ha.

In basic fertilization, the aggregate of the tractor U-650 M and the portable fertilizing machine Nordagri 500 were used. The Nordagri 500 fertilizing machine is a portable machine operated from the tractor's power socket shaft. The capacity of the bunker is 500 l, the maximum payload is 1000 kg and the working width of 12-18 m. Fertilisation was achieved with a constant working speed of 8 km/h, a working width of 12 m, and a fuel consumption of 4 l/ha. The economic indices of the fertilized work are synthesised in (Table 1).

Table 1. Technological chart for the mechanization of fertilization works (expenditures per fertilised ha)

Economic indices	Symbol	RON/ha
Direct expenditures	C_D	42
of which: - wages	C_S	12
- fuel	C_C	20
depreciation	C_A	5
- service	C_{dt}	5
Auxiliary expenditures	C_{ax}	8
TOTAL	C_T	50

Source: Own calculation.

When performing the mechanized ploughing work, the aggregate formed from the Fendt Farmer 311 LSA tractor and the Huard T 130 reversible plough were used. The Huard T 130 reversible plough is equipped with 3 plough bodies. The working width of a plough body is 40 cm. The working width of a plough body is 1.2 m. The display was performed after the bobbin moving method at a depth of 30 cm. The working speed was 8 km/h. Average fuel consumption was 29 l/ha.

The technological chart of ploughing (expenditure per ploughed ha) is shown in (Table 2).

Table 2. Technological chart for ploughing (expenditures per ploughed ha)

Economic indices	Symbol	RON/ha
Direct expenditures	C_D	190
of which: - wages	C_S	19
- fuel	C_C	145
- depreciation	C_A	14
- service	C_{dt}	12
Auxiliary expenditures	C_{ax}	38
TOTAL	C_T	228

Source: Own calculation.

The preparation of the land for sowing was carried out with the agricultural aggregate consisting of the Fendt Farmer 311 LSA tractor and the Ebra 4.5 combinator. For proper preparation of the germination bed, two works with the combiner have been carried out. The technological chart for the mechanization of the germination bed preparation works (two works) is shown in (Table 3).

Table 3. Technological chart for the mechanization of germination bed preparation works (two works)

Economic indices	Symbol	RON/ha
Direct expenditures	C_D	110
of which: - wages	C_S	16
- fuel	C_C	70
- depreciation	C_A	10
- service	C_{dt}	14
Auxiliary expenditures	C_{ax}	22
TOTAL	C_T	132

Source: Own calculation.

The sowing was carried out with the aggregate U-650M tractor + SPC-4F seeder at the distance of 70 cm between rows and 24 cm between grains at a time. Fertilization with complex NPK fertilisers (16:16:16) – 200 kg/ha was performed concomitantly with sowing. The working speed was 6 km/h, the productivity of 0.6 ha/h with average fuel consumption of 6 l/ha. The technological chart of mechanization of sunflower sowing (expenditure per sowing + fertilisation) is shown in (Table 4).

Table 4. Technological chart of mechanization of sunflower sowing (expenditures per sowing + fertilisation)

Economic indices	Symbol	RON/ha
Direct expenditures	C_D	70
of which: - wages	C_S	14
- fuel	C_C	30
- depreciation	C_A	11
- service	C_{dt}	15
Auxiliary expenditures	C_{ax}	14
TOTAL	C_T	84

Source: Own calculation.

The herbicide treatment work was performed with the aggregate of the U-650M tractor + Wirax 400 spreader. Three works were performed: pre-emergent herbicide, post-emergent herbicide, and foliar treatment in vegetation.

The technical characteristics of the Wirax 400 herbicide spreader are:
- Solution tank capacity: 400 l;
- Working width: 12 m;
- No. of hydraulic dispersers with nozzle: 24 pcs;
- Nozzle Type: three-head drip 100-30;
- Solution rule: 40-600 l/ha.
- Working pressure: 2-5 Bar;
- Hydraulic pump type: piston.

The herbicide work was carried out at a speed of 8 km/h at the working pressure of 3 bar, with a 300 l/ha solution. Fuel consumption was 2 l/ha. The technological chart for the mechanization of the herbicide treatment (expenditure per ha – three works) is shown in (Table 5).

Table 5. Technological chart for the mechanization of herbicide treatment (expenditure per ha – three works)

Economic indices	Symbol	RON/ha
Direct expenditures	C_D	60
of which: - wages	C_S	12
- fuel	C_C	30
- depreciation	C_A	9
- service	C_{dt}	9
Auxiliary expenditures	C_{ax}	12
TOTAL	C_T	72

Source: Own calculation.

The work was done with the aggregate of U-650M tractor and CPPM-4 portable cultivator. The cultivator is equipped with 5 sections to be weeded, at a distance between the sections of 70 cm. The sections at the extremities of the frame weed half an interval between the rows. It went into the same traces as the sowing and a number of 4 intervals between the rows at a pass (3 complete intervals + two half-ranges with extreme sections) were weeded.

The working speed was 6 km/h, the productivity of the aggregate of 2 ha/h at a medium fuel consumption of 5 l/ha. The technological chart for mechanization of weeding (expenditure per ha) is shown in (Table 6).

Table 6. Technological chart for mechanization of weeding (expenditure per ha)

Economic indices	Symbol	RON/ha
Direct expenditures	C_D	50
of which: - wages	C_S	13
- fuel	C_C	25
- depreciation	C_A	6
- service	C_{dt}	6
Auxiliary expenditures	C_{ax}	10
TOTAL	C_T	60

Source: Own calculation.

Upon harvesting sunflower, the technical working indices were: speed 4 km/h, productivity 0.7 ha/h, average fuel consumption 10 l/ha. The average production was 2,500 kg grains/ha, fuel consumption was 4 l/t of grains, i.e., a productivity of 1.75 t/h.
The technological chart of mechanization of sunflower harvesting works (expenditure per ha and per t of grains) is shown in (Table 7).

Table 7. Technological chart of mechanization of sunflower harvesting works (expenditure per ha and per t of grains)

Economic indices	Symbol	RON/ha	RON/t
Direct expenditures	C_D	110	44
of which: - wages	C_S	30,0	12
- fuel	C_C	50,0	20
- depreciation	C_A	16,0	6,4
- service	C_{dt}	14,0	5,6
Auxiliary expenditures	C_{ax}	20	8
TOTAL	C_T	130	52

Source: Own calculation.

The costs of mechanized works in sunflower in RON/ha are centralised in Table 8.

Table 8. Technological chart of mechanization of works in sunflower (Expenditure – RON/ha)

Work	Wages C_S	Fuel (Diesel) C_C	Depreciation C_A	Service C_{DT}	Direct expenditures C_D	Auxiliary expenditures C_{AC}	Total expenditures C_T
Fertilisation	12.0	20.0	5.0	5.0	42	8	50
Ploughing	19.0	145.0	14.0	12.0	190	38	228
Soil preparation x 2	16.0	70.0	10.0	14.0	110	22	132
Sowing	14.0	30.0	11.0	15.0	70	14	84
Herbicide treatment x 2	12.0	30.0	9.0	9.0	60	12	72
Weeding x 2	13.0	25.0	6.0	6.0	50	10	60
Harvesting + chopping	30.0	50.0	16.0	14.0	110	20	130
Transport	8.0	25.0	6.0	6.0	45	9	54
TOTAL	124	395	77	81	677	133	810

Source: Own calculation.

Table 9. Materials needed in cultivating sunflower (RON/ha)

Name	Amount (ha)	Value (RON/ha)
Sunflower seeds Syngenta NEOMA CL	60,000 grains/ha	471
Complex fertilisers (4:12:12)	200 kg/ha	260
Complex fertilisers (16:16:16)	200 kg/ha	324
Pesticides		659
Supplies expenditures	-	124
TOTAL	-	1,838

Source: Own calculation.

CONCLUSIONS

The following conclusions and recommendations are drawn from the studies carried out:
The total expenditure for mechanized works in sunflower was 810 RON/ha, of which 677 RON/ha (80%) direct expenditures and 133 RON/ha (20%) indirect expenditures.
From the value of direct expenditures of 677 RON/ha, 19% (124 RON/ha) represents wages, 58% (395 RON/ha) represents diesel, 11% (77 RON/ha) is the 12% depreciation, and (81 RON/ha) is technical service.
Fuel expenditure (395 RON/ha) accounts for 49% of the total expenditures of mechanized works.
If the total expenditure of the mechanized works of 810 RON/ha is added to the value of the materials required for the sunflower culture of 1,838 RON/ha, it follows that the total expenditure amount was 2,648 RON/ha and 1,059 RON/t, respectively.
Taking into account that the average sunflower production was 2,500 kg/ha and that the price of sunflower was 1.35 RON/kg, it follows that the value of production was 3,375 RON/ha. Therefore, the profit per ha was 727 RON, respectively 22% of the average production value per ha of sunflower.
Factors that influenced sunflower production in 2019 were climatic conditions, crop rotation, soil fertility, mechanical work quality, sowing time, and cultivated hybrid.
In order to gain profit in sunflower, in climatic conditions specific to the Şimleu Depression, the choice of hybrids adapted to climate and soil conditions in the area is recommended.
Under the conditions of 2019, with a summer drought period, it has been proven that sunflower can provide good production and profit for growers in the Ip, Sălaj County area, Romania.

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