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STUDIES ON THE TECHNOLOGY OF MECHANISM FOR CORN CULTIVATION

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***Abstract**. This paper aims to analyze the consumptions and costs involved in the mechanized works and materials used in maize cultivation, with the main objective of optimizing the cultivation technology. The study aims to identify the main sources of costs, evaluate the efficiency of the resources used and propose technological solutions that contribute to increasing sustainability and productivity in this culture. To achieve this objective, the analysis focuses on the following aspects:*
-evaluation of energy consumption and costs of mechanized works, such as soil preparation, sowing, fertilizing, weeding and harvesting.
-identifying and optimizing the costs of materials used, including seeds, fertilizers, herbicides and other agricultural inputs.
- the comparison between traditional and modern culture technologies, considering the economic and ecological impact.
- proposing innovative practices to reduce consumption and costs without compromising production quality. This approach enables the development of practical solutions for farmers, supporting the adoption of more efficient and environmentally friendly farming methods, in the context of the growing demands for sustainability in agriculture. The study presented in this paper has as its object of analysis a representative area of the Arad Plain, an integral part of the Western Plain, characterized by geographical, pedological and climatic conditions favorable to the cultivation of corn. The locality analyzed falls within the specific landscape of this region, providing a relevant agricultural context for the evaluation of consumption and costs associated with culture technologies. The detailed analysis mainly covers:
-consumption and efficiency of mechanized works – including soil preparation works, sowing, maintenance and harvesting of crops.
-materials used in the agricultural process – such as seeds, fertilizers and plant protection products, considering their impact on total costs.
- the correlation between the technology applied and the productivity achieved, to identify ways to reduce costs and increase efficiency. The obtained results are relevant for the farmers of Câmpia Aradului, offering conclusions and recommendations that reflect local specificities and contribute to the improvement of agricultural practices in the area. The study also emphasizes the importance of adopting technological solutions adapted to local conditions, in order to increase the sustainability and competitiveness of the agricultural sector. The intensive use of agricultural machinery plays an essential role in the modernization and efficiency of the agricultural sector. Through the application of advanced mechanization, labor productivity increases significantly, which leads to the optimization of agricultural processes and the achievement of higher yields per unit of time. This progress allows:
-increasing the efficiency of the use of agricultural resources, by reducing unnecessary consumption and more precisely allocating inputs such as fuel, seeds and fertilizers.
-reducing the execution time of agricultural works, which supports a better management of the agricultural calendar and avoiding losses caused by unfavorable weather conditions.
-expanding mechanization and automation, which allows farmers to manage larger areas with less physical effort, thus improving the profitability and economic viability of farms. In the current context, where the demand for food products is constantly increasing, intensive mechanization supports farmers in feeding an increasing number of people. This contributes to ensuring global food security and the development of a more sustainable agriculture, able to meet both the needs of the population and the requirements of environmental protection. The adoption of modern technologies in mechanization not only improves productivity, but also helps to reduce the negative impact on the environment, thus contributing to the development of a more balanced and sustainable agricultural sector.

***Keywords** soil, corn, agricultural machines, economic efficiency*

INTRODUCTION

Romania's agriculture has experienced numerous transformations in recent years, one of them constituting the transition from state to private agriculture. (VLAD DRAGOSLAV MIRCOV, ET AL, 2024) Like more developed countries, and in our country, the aim is to increase labor productivity through the mechanization of agriculture and practicing it in a scientific way that results in a performing agriculture in terms of economic and ecological point of view. Obtaining high-quality harvests, under certain conditions costs as low as possible, can only be achieved by applying specific technologies perfected, which allow a superior valorization of natural resources and inputs.(NICOLETA MATEOC-SÎRB, ET AL 2024, NICOLETA MATEOC-SÎRB, ET AL, 2022, TEODOR MATEOC, ET AL, 2024)

The intensive use of agricultural machines ensures the increase of labor productivity in agriculture, makes it possible that parallel to the expansion of mechanization, each agricultural producer can feed, through the products obtained, an increasing number of people.(NIȚĂ L., ET AL, 2024)

Corn mechanization includes a set of specialized processes and technologies that improve the efficiency of growing, maintaining, and harvesting corn crops. These technologies are continuously developing, with the aim of reducing costs and increasing productivity, but also improving the quality of crops. (ADALBERT OKROS, ET AL, 2024)

Maize mechanization technology of knowledge of rapid development, adapting to the requirements of modern agriculture, where sustainability and efficiency are priorities. This evolution allows the implementation of agricultural practices that combine increased productivity with environmental protection and conservation of natural resources. Maize is a versatile crop, adaptable to a wide range of soils, including soils with different fertility levels, textures and chemical reactions.(DURAU CARMEN CLAUDIA, ET AL, 2022)

Maize, having a high productive potential, has high nutritional requirements and consumes significant amounts of essential elements for its optimal development. Nutrients are intensively used for the formation of both grain and secondary production (stems, leaves) (CASIANA MIHUȚ, ET AL, 2024). Chemical fertilizer doses are calculated based on a number of factors that directly influence the nutritional needs of the corn crop and its production potential. Key considerations include: -expected production level – the production objective influences the amount of nutrients needed to support plant growth and grain formation. The specific consumption of maize – according to the standard amounts of nitrogen (N), phosphorus (P_2O_5) and potassium (K_2O) required for each 1000 kg of production. Soil nutrient reserves – assessed through soil analyses, which determine the availability of essential nutrients and the need for supplementation through fertilization.(CASIANA MIHUȚ, ET AL, 2024, CASIANA MIHUȚ, ET AL, 2022)

Phosphorous fertilizers are incorporated into the soil under deep plowing, and in exceptional cases they can be applied in early spring before the preparation of the seed bed. They are also well utilized if they are applied together with sowing in the form of complex fertilizers. Doses of 60-150kg/ha of this element are applied to soils very poor in potassium.

Plowing is performed immediately after the release of the land by the preceding plant at a depth of 25-30 cm. Spring plowing must be excluded, being able to be replaced by repeated discussions and harrowing on lands clean of weeds and well supplied with water. In extreme situations when it is necessary, spring plowing must be done as early as possible and of good quality. The preparation of the germinal bed aims at leveling the land and creating a layer of loosened and shredded soil at the sowing depth through the least possible number of passes on the land. The sowing season corresponds to the period when the temperature in the soil at a depth of 10 cm stabilizes above 8-100 C. The sowing thickness is a very important technological factor and is determined according to the duration of the vegetation period of the sown population, the water reserve from the soil and the degree of soil supply with nutrients. Early populations with a density of 50,000-60,000 plants/ha are used for the cultivation area of Mureș. Sowing is done with the SPC-6 precision machine at a distance between rows of 70cm and a depth of 5-8cm, ensuring 15-25kg of seed/ha. When the area to be sown is very small (less than 100 square meters), the work is carried out manually with a hoe, furrows are made with a depth of 6 cm, at a distance of 70 cm between furrows, and the corn seeds are placed on the bottom of the furrow at distances of 20-25 cm. It is good to put two seeds at a time. If it is sown after corn, it is advisable to treat the seeds, before sowing, against the wireworm and the corn leaf weevil with NUPRID AL 600 FS, (60 ml/10 kg of seeds). On the day of sowing, sprinkle the seeds with this solution, taking care to apply it to the entire quantity of seeds. In order to avoid the use of insecticides, do not sow corn after corn or in newly cultivated fields (lucerniere). (D POPA, ET AL, 2022, DUMA COPCEA ANIȘOARA, ET AL, 2024)

In the classic corn technology, 3-4 mechanical slings between rows and 2-3 manual slings per row are required. The first 2-3 weeks after emergence are the critical phase in corn care, and weeding is carried out at intervals of 10-20 days depending on the appearance of weeds, ensuring that the corn field is kept clean. The working depth and the speed of movement of the aggregate in the mechanical harrows are imposed by the state of vegetation of the plants and the development of the root system as follows: - in the first harrow, 10-12 cm deep, speed 4 km/hour; - at the second grid, 7-8 cm deep, speed 8-10 km/hour; - at the 3rd grid 5-6 cm deep, speed 10-12 km/hour. To reduce the degree of weed infestation, a chemical control with BASIS can be carried out. This herbicide is applied after the corn plants emerge, when they have 4 leaves, applying 0.8 - 1.0 l/ha. There is a very varied range of weed control substances, but in general, we need to know the weeds that appear in the field sown with corn in order to use the most appropriate herbicide. If the use of chemical substances is not desired, then the number of manual harrows will be increased and it will be observed that the corn follows a crop that has left the land clean of weeds. In our country, the most feared pest is the corn leaf weevil. In corn grown 2-3 years after itself, the density of the weevil can exceed 30 individuals per m2. Plants are destroyed by this insect from the emergence phase. Given the fact that this insect attacks several plant species, corn should not be sown after sunflowers, beans, soybeans and sugar beets. Crop rotation is undoubtedly a phytotechnical measure of the greatest importance in combating the weevil. As a chemical measure, it is the one mentioned in the "Seed and sowing" point. Another pest that appears in corn in some years is the corn borer. This insect is frequently encountered when we grow sweet corn. In general, corn populations from the hardy and toothed convariety are resistant to this pest. (DAVID, SAIDA FEIER, ET AL 2020)

Harvesting corn in the form of cobs is done when the moisture of the grains is between 22-30%, and the black layer that separates the grain from the rachis (cob) can be observed.

To obtain a population that respects the original genetic structure, it is necessary to sow in isolated spaces. This means that each population must be sown at a distance of 700m from another maize hybrid or population. If these isolation distances are not respected, different biotypes will result from the original population, and within 2-3 years a new population will be obtained that will be totally different from the original one. (DUMA COPCEA ANIȘOARA, ET AL, 2023, DUMA COPCEA ANIȘOARA, ET AL, 2024) Care work and sowing distances are the same as for consumption. Harvesting is done at the time of harvest, when the humidity of the seeds is not higher than 20%. The largest cobs are chosen, which have the shape and color of the original population. They are put to dry in the attic of the house, and in the spring, before sowing, they are removed from the cob. Remove the seeds from the tip and base of the cob. The seeds chosen must be healthy, not attacked by storage pests (cereal weevil, cereal moth). (S BUNGESCU, ET AL, 2021)

MATERIAL AND METHOD

For the weeding work, the aggregate composed of the John Deere 7230 R tractor + the Lemken Rubin 9/500 disk harrow was used

The technical characteristics of the Lemken Rubin 9/500 disc harrow are as follows:
- Working width: 5 m;
- Transport width: 2.8m;
- Working depth: 5-20 cm;
- Number of disks: 40 pcs (independent);
- Disc diameter: 62 cm;
- Disc rows: 2 rows (in X);
- Roller diameter: 40 cm;
- Mass: 3330 kg;

Power required for aggregation: 175-250 hp (129-184 kW).

The working speed of the aggregate was 12 km/h. The productivity of the weeding aggregate is 6 ha/hour with a diesel consumption of 12 l/ha.

Fertilization works for the maize crop were:

- Basic fertilization with NPK complex fertilizers (12:37:0) – 250 kg/ha;
- Fertilization with urea (46% N) – 150 kg/ha;
- Fertilization with ammonium nitrate (33.5% N) – 150 kg/ha.

The aggregate consisting of the Deutz Fahr 150 tractor + the Eurospand Jolly 32 fertilizing machine was used for the fertilization works (figure 3.2).

The Eurospand Jolly 32 fertilizer spreader is a machine carried and driven from the PTO shaft of the Deutz Fahr 150 tractor.

- Working width: 24 m;
- Fertilizer hopper capacity: 3000 liters.

When calculating the economic indicators of the aggregate to be fertilized, the speed of 10 km/h, the consumption of 3 l/ha and the productivity of 12 ha/h were taken into account.

Plowing is the land work with the highest energy consumption. For the corn crop, plowing must be done at a depth of 25-30 cm in autumn as early as possible so that the soil freezes over the winter and the clods crumble. Favorable conditions for storing water reserves in the soil and a good preparation of the soil in the spring with the combinator are thus achieved.

The **plowing** work was carried out with an agricultural aggregate composed of: John Deere 7280R tractor + Lemken Europal 9/5+1 plow

The Europal reversible plow is equipped with a hydraulically controlled reversing device, with support wheel and adjustment for transport and plowing depth, with double bodies and forebodies.

The working width of a piece is 35 cm, the distance between the pieces is 100 cm, the working width is 175 cm. The mass of the plow is 1800 kg.

The exploitation indices for plowing were:

- aggregate speed: 9 km/h;
- hourly productivity: 2 ha/h;
- diesel consumption: 23 liters/ha.

Land preparation for sowing was done in the spring with the combine. This agricultural machine was chosen because it does not overturn the soil and preserves the water reserve in the soil. To avoid land subsidence through several works, the Lemken Korund 8/600K vibratory cultivator was used

The technical-constructive characteristics of the vibrocultivator are:

- Working width: 600 cm;
- Number of sections: 4 pcs.;
- Harrow length: 150 cm;
- Number of rollers: 8 pcs (2 per section);
- Roller diameter: 33 cm (first) and 27 cm (second);
- Leveling bar: 4 pcs (1 per section);
- Number of active organ rows: 4;
- Number of active bodies: 64 (16 per department);
- Mass: 1952 kg;
- Required power for operation: 105-175 HP.

The exploitation indices for the work with the combiner were:

- aggregate speed: 14 km/h;
- hourly productivity: 9 ha/h;
- diesel consumption: 8 liters/ha.

Corn was sown in April 2018. The sowing density was 57,000 grains/ha. The distance between the rows was 70 cm. Sowing unit: John Deere 5100M tractor + Gaspardo-MT seeder

The Gaspardo MT precision seeder is equipped with an on-board device and reading sensors for each row sown. In this way, the quality of sowing, the number of grains sown on the surface and the number of hectares sown are monitored. The pneumatic actuation of the exhauster is done from the tractor's power take-off shaft. The hydraulic system of the tractor drives the track markers of the seeder. The rate of grains per hectare is adjusted by changing the transmission ratio between the gear wheels of the distribution.
The sowing work was carried out as follows: first the ends of the plot were sown (24 rows – 4 passes) to ensure the return zone and then it was sown in length by moving the aggregate following the track of the marker.
The exploitation indices for the sowing work were:
- aggregate speed: 7 km/h;
- hourly productivity: 2.5 ha/h;
- diesel consumption: 5 liters/ha.

The protection works for the corn crop, in the Parţa area, were carried out to combat weeds, diseases and pests. Two works were carried out: pre-emergence herbicide and foliar treatment. The Bargam 4000 herbicide machine was used in aggregate with the Deutz Fahr 150 tractor.
The trailed herbicide machine Bargam 4000 has the following technical characteristics:
- solution tank volume: 4000 liters;
- opening of the sprinkler ramp: 24 meters;
- number of hydraulic dispersers with nozzle: 48 pieces;
- hydraulic pump for the solution: maximum pressure – 20 bars; flow rate – 240 liters/min;

The exploitation indices for the herbicide work were:
- aggregate speed: 7 km/h;
- hourly productivity: 15 ha/h;
- diesel consumption: 2 liters/ha.

A quantity of solution of 300 liters per hectare was uniformly distributed. For this, the solution flow rate and the working pressure from the machine's distributor were adjusted. The actual solution flow rate was 84 liters/min, respectively 1.75 liters/min per nozzle.
Maize was harvested as grain with a John Deere W550 self-propelled combine equipped with a Capello R6 6-row cob picker
First the ends of the plot were harvested (24 rows – 16 meters) to ensure the return area of the combine, after which it was harvested lengthwise with return at the looped ends.
Simultaneously with the harvesting of the grain corn, the cob picker also chopped the corn cobs.
At harvest, an average production of 8400 kg of grains/ha was obtained.
Operating parameters of the John Deere W 550 combine
- John Deere Power Tech diesel engine – 275 HP;
- Diesel tank capacity: 800 liters;
- central conveyor with 3 chains with scrapers;
- diameter of the beater of the threshing machine: 660 mm;
- beater length: 1400 mm;
- number of beating rails: 10 pcs.;
- dimensions of the contraband: 750 mm x 1400 mm;
- beater speed: 450 – 1080 rpm;
- separation system: 5 belts with 11 steps;
- the active area of the beds: 6.4 sq m;
- adjustable sewing cleaning system and fan: Dual-Flo;
- the active surface for separating the sites: 5.2 sq m;
- bunker volume: 8000 liters;
- discharge flow rate: 5300 liters/min.

Technical characteristics of the Capello R6 cob picker

- Width of the cob picker: 4.9 meters;
- number of work sections: 6 pieces;
- distance between sections: 0.7 meters;
- number of stem choppers: 6 pieces;
- number of chopping knives: 18 pcs. (6 x 3 on each chopper);
- mass of the picker: 2050 kg.

The technical indicators for harvesting grain corn were:
- combine speed: 6 km/h;
- hourly productivity: 2.5 ha/h;
- diesel consumption: 20 liters/ha.

RESULTS AND DISCUSSION

The mechanization technology applied in the cultivation of corn in the Parța area, Timiş county aimed to implement effective agricultural practices for the preparation and maintenance of the soil, optimizing the available resources and increasing the productivity of the crop.

Mechanization of soil maintenance works

One of the important stages, the mechanization of the weeding works, was carried out in the summer, immediately after harvesting the grassy cereals, with the following objectives:

-conserving water in the soil: By weeding at a shallow depth of 10 cm, a protective layer has been formed that reduces evaporation and conserves moisture.

-closing the soil pores: The layer formed by plant debris and dislodged soil particles helped to reduce water loss, thus improving the conditions for the future crop.

Management of plant residues: The works helped to incorporate the plant residues resulting from the harvest, favoring the decomposition process and enriching the soil with organic matter.

The advantages of applied technology

Water efficiency: Conserving water in the soil is essential for corn, especially during the frequent dry spells in this area.

Reduction of soil erosion: By forming the protective layer, the risk of wind or water erosion has decreased.

Improving soil structure: Plant residues incorporated into the soil contributed to maintaining a good level of fertility and developing an optimal structure for the next crop.

The economic indices of the de-soil aggregate are shown in the table 1.

Table 1

Economic indicators of deforestation works (expenses per hectare discussed)

Nr.	Economic indices		lei /hectar
1	Direct expenses		95
	of which:	-payroll expenses	3
		- fuel expenses	72
		- amortization expenses	9
		- technical service expenses	11
2	Ancillary expenses		19
3	**TOTAL**		**114**

The economic indices of the aggregate to be fertilized are shown in the table 2.

Table 2

Economic indices of fertilization works (expenses per hectare – 3 fertilization works)

Nr.	Economic indices		lei /lucrare	lei /ha
1	Direct expenses		25	75
	of which:	-payroll expenses	2	6
		- fuel expenses	18	54
		- amortization expenses	2	6
		- technical service expenses	3	9
2	Ancillary expenses		5	15
3	**TOTAL**		**30**	**90**

The description of the plowing work on the plot intended for corn cultivation followed the observance of standard mechanized technology, ensuring an optimal preparation of the soil for sowing. The work stages were carried out as follows:
Stages of the work:
Drawing control furrows:
Control furrows were made at the ends of the plot.
This step allows the delimitation of the machine turning area and prevents the formation of gaps or overlaps in the end area.
The actual plowing:
The work was carried out along the length of the plot, using the wave method.
The wave method involves moving the plowing aggregate with turning the furrows laterally, in the same direction.
This technique ensures even turning of the furrows, improving soil aeration and mixing.
Plowing the ends of the plot:
After the lengthwise plowing was completed, the ends of the plot were worked.
The furrows in this area were turned towards the already plowed land, ensuring uniformity of the work and avoiding unevenness of the soil at the edges.
The economic indices of the plowing aggregate are shown in the table 3

Table 3

Economic indices of the plowing work (expenses per plowed hectare)

Nr.	Economic indices		lei /hectar
1	Direct expenses		164
	of which:	-payroll expenses	12
		- fuel expenses	132
		- amortization expenses	11
		- technical service expenses	9
2	Ancillary expenses		33
3	**TOTAL**		**197**

The economic indices of the aggregate to be prepared are shown in the table 4.

Table 4

Economic indices of the total cultivation work (expenses per hectare worked with the combine)

Nr.	Economic indices		lei /hectar
1	Direct expenses		58
	of which:	-payroll expenses	3
		- fuel expenses	48
		- amortization expenses	4
		- technical service expenses	3
2	Ancillary expenses		12
3	**TOTAL**		**70**

The economic indices of the sowing aggregate are shown in the table 5.

Table 5

Economic indicators of the corn sowing work (expenses per hectare sown)

Nr.	Economic indices		lei /hectar
1	Direct expenses		50
	of which:	-payroll expenses	14
		- fuel expenses	30
		- amortization expenses	3
		- technical service expenses	3
2	Ancillary expenses		10
3	**TOTAL**		**60**

The economic indices of plant protection works are shown in the table 6.

Table 6

Economic indicators of herbicide and foliar treatment works (expenses per hectare for two works)

Nr.	Economic indices		lei /hectar
1	Direct expenses		35
	of which:	-payroll expenses	4
		- fuel expenses	24
		- amortization expenses	4
		- technical service expenses	3
2	Ancillary expenses		7
3	**TOTAL**		**42**

The economic indices of the works for the works of harvesting corn kernels are shown in the table 7

Table 7

Economic indices of the works of for the works of harvesting corn grains

Nr.	Economic indices		lei /hectar
1	Direct expenses		154
	of which	-payroll expenses	12
		- fuel expenses	120
		- amortization expenses	10
		- technical service expenses	12
2	Ancillary expenses		31
3	**TOTAL**		**185**

The economic indices of the works for the transport works are reproduced in the table 8.

Table 8

Economic indices of the works of for the transport works

Nr.	Economic indices		lei /hectar
1	Direct expenses		76
	of which	-payroll expenses	9
		- fuel expenses	54
		- amortization expenses	7
		- technical service expenses	6
2	Ancillary expenses		15
3	**TOTAL**		**91**

The total costs of the mechanized works carried out on the corn crop are centralized in table 9. These expenses are expressed in lei per hectare and are calculated without VAT.

Table 9

Expenditure on mechanized works for corn cultivation (lei/hectare)

Nr. crt	Work	Salary	Diesel fuel	Amortization	Technical service	Direct expenses	Ancillary expenses	Total expenses
1	Stubble-turning	3	72	9	11	95	19	114
2	Fertilization x 3	6	54	6	9	75	15	90
3	Plowing	12	132	11	9	164	33	197
4	Prepared ground	3	48	4	3	58	12	70
5	Sowing	14	30	3	3	50	10	60
6	Sprayers x 2	4	24	4	3	35	7	42
7	Harvested + chopped	12	120	10	12	154	31	185
8	Transport	9	54	7	6	76	15	91
TOTAL		**63**	**534**	**54**	**56**	**707**	**142**	**849**

The necessary materials for the corn culture were: corn seed, fertilizers, pesticides, etc. The expenses with these materials, calculated in lei/ha, are shown in the table 10.

Table 10

Materials needed for corn culture (lei/hectar)

Nr. crt	Work	Amount/ha	Value (lei/ha)
1	Corn seed	57000 b./ ha	586
2	Complex fertilizers (12:37:0)	250 kg/ha	480
3	Ammonium nitrate + urea	300 kg/ha	540
4	Pesticides	-	315
5	Supply expenses	-	127
	TOTAL	**-**	**2048**

CONCLUSIONS

The present work presents the culture technology of the corn crop in the Parta area, Timis county

Maize cultivation technology has evolved significantly, transforming traditional agriculture into an activity of high precision and efficiency. By mechanizing the stages of soil preparation, sowing, maintenance and harvesting, farmers can achieve higher and higher quality crops while reducing labor costs and losses.

The central problem of rational mechanization is to optimize the coordination of work and machinery throughout the entire technological process to produce results with a minimum consumption of labor and energy. By using modern technologies of mechanization, chemicalization, fertilization and by choosing varieties suitable for different types of technologies, superior results can be achieved from an economic point of view, ensuring a higher production with low costs in terms of fuel consumption. Another significant advantage is that work is carried out at the optimal time for mechanization, thus maximizing efficiency.

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