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ECONOMIC EFFICIENCY OF MAIZE CROP IN SMALL FARMS IN THE SOUTH WEST OF OLT COUNTY, ROMANIA

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Abstract

A simple experiment was carried out at three neighboring micro-farms where the owners agreed to implement some proposed technologies in which the influence of differentially applied agricultural works and the influence of some inputs on corn production will be tested. The micro-farms are located in the South-West part of Olt county in the vicinity of Dolj county. Conventional works and minimum tillage were executed. For the conventional works, the farmers continued to use their knowledge of corn cultivation. For the proposed technologies, they received nitrogen 70 kg ha-1, phosphorus 90 kg ha-1 and NPK 8.15.15 + 3%CaO+ 9%S 200 kg ha-1. In the short run, it has been observed that employing minimum tillage alongside soil fertility management technologies proves more beneficial in boosting maize yield under conditions of limited rainfall compared to conventional tillage methods.

Key words: *maize, minimum tillage, fertility management, efficiency*

INTRODUCTION

The application of the technique of integrated management of soil fertility, depending on the physical and chemical properties, leads to obtaining increased productions even in the conditions of periods with low precipitation. This technique is primarily favorable for owners of small areas and who do not have enough inputs for the food source for plants. [12].

Components of ISFM such as manure, leguminous crops, mulch, etc. they increase plant nutrient availability, microbial quality and soil physical properties [11, 5] leading to increased agricultural production. Small farmers apply little chemical fertilizers in order to increase soil fertility [8].

Monoculture leads to a decrease in fertility [15, 16] and excessive tillage has a negative effect on fertility [13]. This is not justified by inconsistencies related to how the soil is worked with effect on quality parameters [13]. It was thus hypothesized that the technologies implemented through conventional and minimal soil work significantly improve its properties [3, 4]. Nitrogen, phosphorus, potassium fertilizers applied in corn culture increase production and the evaluation of ISMF by farmers increases the probability of their adoption.

In this context, the purpose of the paper is to test some technologies for maize crop in micro-farms situated in the South West part of Olt County. In this experiment, conventional system of agriculture was compared to minimum tillage technology with soil fertility management in order to evaluate the impact on production.

MATERIALS AND METHODS

Site description

This study was carried out on a plot of land in the southern part of Olt county on an area of 4.5 hectares collected from three farmers. According to the classification of soil taxonomy, the soils arezonal chernozems, whose properties are presented in Table 1. The soils are slightly inclined, 0 + 1%, deeply profiled, located on very old subsoil alluvium. Soil samples were taken at 0 - 15 cm depth at the beginning of the experiment. The resulting values are presented in Table 1. For pH, a pH meter model FLO 89000 was used, which displays the soil moisture, the pH reagent and the temperature.

Farmer selection and interviews

Three farmers were selected, each with an area of 1.5 hectares on a random location in the same locality, trained and guided in choosing the technologies to be implemented.

The selection of farmers was based on the availability to implement the proposed technologies in terms of tillage, treatments, in the annual agricultural season. At the end of the experiment, selected farmers were interviewed to evaluate the new technology.

They answered questions regarding the implementation of the technology and whether they would recommend the technology to other farmers.

Of the technologies implemented by each farmer, one was a control (conventional work without inputs), abbreviated **CvCon**.

The other applied technologies were MinTill = minimum tillage; + Mineral fertilizer+ SOLFERT 10-5-40+ME abbreviated Min Till Îc Îls and MinTill=minimum tillage; + Mineral fertilizer abbreviated **MinTill Îc**.

For the control area, the small farmers applied the technologies used in the respective area: plowed at 22 cm, the soil was loosened twice, sown, administered chemical fertilizers (ammonium nitrate), cultivated, harvested.

At the beginning of the season, the farmers received fertilizers and corn. We used NPK 15:15:15, ammonium nitrate.

The amount of biomass on the studied land area was not taken into account.

SFI- soil fertility input

CvCon- conventional tillage without inputs

MinTill Îc - minimum tillage; + Mineral fertilizer

Min Till Êc Íls - minimum tillage; + Mineral fertilizer+ SOLFERT 10-5-40+ME

Note: application doses of inputs:

Mineral fertilizer = 60 kg N ha^{-1}, 90 kg P ha^{-1};

Plowing (CvCon) was executed at 22 cm. Pentru (Min-Till) the executed depth was 15 cm.

This was achieved through reduced tillage methods that involve less soil disturbance compared to conventional plowing, aiming to preserve soil structure and reduce erosion while still adequately preparing the land for planting.

Corn was sown at a distance of 0.70 m between rows and 0.28 m between seeds per row.

Calculated number of seeds per hectare was 50,000 grains.

The predominant corn variety utilized in the local area is commonly planted and well-suited for the region under investigation. Agricultural equipment such as the Kuhn Maxima Monosem Amazone seeder equipped with microgranular corn discs, fertilization discs, and a seed control monitor is employed for precise and efficient corn seeding. Additionally, a herbicide installation with a 400-liter capacity, covering a 12-meter working width and featuring a sprayer equipped with three nozzles, notably the Demarol Cyklon, is utilized for effective weed control. The farming machinery roster includes a CLAAS 685 tractor for various agricultural tasks and a corn combine harvester for efficient corn harvesting operations.

The small farmers independently applied the necessary agronomic practices according to the training

Data collection

Soil samples were taken at the end of the experiments at the specified depth to be analyzed in order to determine the chemical properties. Phenological data were recorded together with the researchers. Corn cobs were harvested and weighed from the measurement plots with an area of 21 m^2.

Samples taken were dried to a constant weight. The spikelets were dried and the grains separated by hand. Grain moisture was determined with portable grain moisture analyzers. The weight of the grains was determined at a moisture content of 12.5%.

RESULTS AND DISCUSSIONS

Table 1 presents the soil chemical properties at a depth of 0-15 cm, indicating important factors for crop growth and nutrient availability. These properties include total nitrogen (N), available phosphorus (P), total organic carbon (C), exchangeable potassium

(K), exchangeable magnesium (Mg+), exchangeable calcium (Ca), C/N ratio, and pH. The values provided offer insights into the soil's fertility status and its potential to support crop growth.

Table 1. Soil chemical properties (0 – 15 cm)

Chemical properties	Unit	Value
N total	%	0.10
Available P	mg kg^{1}	43.00
Total organic C	%	0.81
Exchangeable K	cmol kg K^{-1}	1.25
Exchangeable magnesium Mg^{+}	cmol+kg^{-1}	1.396
Exchangeable calcium Ca^{+}	cmol+ kg^{-1}	11.49
Report C/N		8.10
pH water (1:1, soil:water)	Ph units	5.84

Source: Own determination.

Tables 2, 3, and 4 outline the inputs and associated costs for different agricultural practices: Minimum Tillage (+ Mineral Fertilizer), Minimum Tillage (+ Mineral Fertilizer SOLFERT 10-5-40+ME), and a Control setup, respectively. Each table itemizes the quantity and cost of various inputs such as workforce, fuel, fertilizers, seed, and herbicide for the specified agricultural practices (Fig.1).

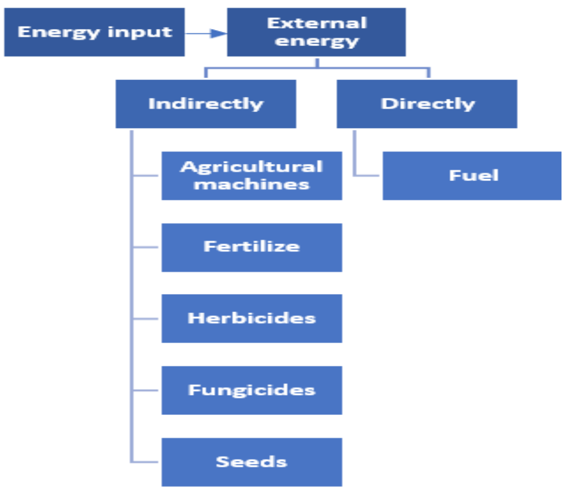

Fig. 1. Cost categories associated to the technology
Source: Authors' conception.

Most farmers showed a preference for technologies incorporating higher levels of soil fertility inputs, regardless of the tillage method employed. The most favored technologies were MinTill Îc (involving minimum tillage with added mineral fertilizer) and Min Till Îc Îls (involving minimum tillage of soil with additional mineral fertilizer, SOLFERT 10-5-40, and microelements). These technologies were preferred due to the accessibility of inputs, ease of implementation, and their ability to enhance production. We observed that the CvCon paper was preferred by a few farmers for ease of implementation, but not by the majority of small farmers.

Table 2. MinTill Îls (minimum tillage; + Mineral fertilizer)

Inputs		Quantity	Costs, lei
Workforce		16 h	16 x 33 = 528
Machinery			
Fuel	Diesel	77 L	77x 8.20 = 631.4
Fertilizers	N P K	200 Kg	4x 245 =980
Seed	Local variety	3x25,000 grains	3x152 =304
Herbicide	Corn Herbicide NICORN 040 SC	5 L	238
Total			**2,681**

Source: Own calculation.

Table 3. Min Till I Îls (minimum tillage; + mineral fertilizer SOLFERT 10-5-40+ME)

Inputs		Quantity	Costs, lei
Workforce		16 h	16 x 33 = 528
Machinery			
Fuel	Diesel	107 L	107 x 8.20= 877.4
	N P K	200 Kg	4x 245 =980
	Solfert 20-20-20 +ME	3 Kg	3x 17.8 =53.4
	Local variety	3x25,000 grains	3x152lei = 304
	Corn Herbicide NICORN 040 SC	5 L	238
Total			**2,980.8**

Source: Own calculation.

Table 4. Control

Inputs		Quantity	Costs, lei
Workforce		40 h	40 x 33 = 1,320
Machinery			
Fuel	Diesel	67 L	67x8.20= 549.4
Fertilizers	Ammonium nitrate	300 Kg	1,541
Seed	Local variety	3x25,000 grains	3x152lei = 304
Herbicide	Corn Herbicide NICORN 040 SC	5 L	238
Total			**3,952.4**

Source: Own calculation.

MinTill maintained soil moisture and favored the mineralization and accumulation of nitrogen in the soil. Other authors have extensively discussed the capacity of MinTill to preserve soil moisture and its impact on biochemical processes, as evidenced by works by [1, 2].

Tillage practices have been shown to stimulate acid-phosphomonoesterase activities, thereby promoting phosphorus mineralization, as alterations to the soil surface prompt responses in the soil's biochemistry and biology, as indicated by [9].

Yields of corn kernels and plant residues

The tillage method did not significantly affect the amount of corn grains and the yield of plant residues in the three locations (Table 5).

Table 5.Comparison of the average production of grains and vegetable residues in corn

Work	Average grain production, t/ha	Average production of vegetable residues, t/ha	The proportion of grains-vegetable remains
Conventional control + Ammonium nitrate 33.5% N	4.2	4.3	1:1.04
MinTill=minimum tillage;+ Mineral fertilizer	5.6	6.16	1:1.1
MinTill=minimum tillage; + Mineral fertilizer + SOLFERT 10-5-40+ME	7.1	9.23	1:1.3

Source: Own calculation.

The notable rise in maize yield observed during the 2022 harvest season, attributed to the interaction between tillage practices and Soil Fertility Inputs (SFIs), may be linked to elevated soil moisture levels and enhanced availability of plant nutrients resulting from SFIs in the soil, similar to findings reported in studies conducted by [6 and 17].

Higher corn yields could be related to readily available nitrogen from inorganic fertilizers while organic inputs could have released organic acids that increased soil pH [14]. Their capacity to release phosphorus and facilitate the availability of other nutrients for crop absorption can result in heightened maize production, consistent with findings reported by [10].

Likelihood of adoption of experienced ISFM technologies

All participating farmers who implemented ISFM under both conventional and minimum tillage conditions considered that they would continue to use ISFM technologies, and would recommend them to other farmers.

[7] found that farmers prefer technologies for increasing corn production.

The involvement of small farmers in the implementation of the project influenced the decision of other farmers to use the applied technologies.

Farmers commonly practice conventional tillage. The willingness to use minimum tillage is supported by the possibility of using the tillage method on a wide range of crops, under different climate and soil conditions.

Short-term threats to the adoption of the technologies used in this study included the unwillingness of smallholder farmers for their transmission from farmer to farmer. The same was found by [11].

Adoption of ISFM can be improved by disseminating information in the area The duration of the experiment coincided with the agricultural season for the maize crop in the year 2022 of 133 days.

CONCLUSIONS

Minimum tillage with integrated soil fertility management technologies was more effective in increasing maize production under conditions of a reduced amount of precipitation than in the case of conventional tillage.

We used the results as a proxy to assess the likelihood of farmers adopting the implemented ISFM technologies.

It could be observed that a higher production is obtained if a larger amount of fertilizers is used, but it is not a direct proportional relationship between the level of fertilization and the productive level. Thus, other work options can be observed that are more efficient. A long-term performance evaluation study under both tillage methods is needed for site-specific recommendations

The increase in corn production under different changes in soil fertility and the participation of farmers in their implementation ensures the probability of their being taken over by farmers in the area

To advance the adoption of these technologies, it is imperative to encourage the farmer-to-farmer learning approach.

The primary obstacle in utilizing corn as a soil fertility enhancer stems from its predominant use as animal feed.

There is a crucial necessity to educate farmers on achieving a balance between utilizing maize as animal feed and as a soil fertility input.

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