PRELIMINARY STUDY ON THE INFLUENCE OF THE MINIMUM TILLAGE SYSTEM ON THE PRODUCTIVE CAPACITY OF CORN GROWN UNDER ARDS CARACAL CONDITIONS

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Abstract

The importance of maize (Zea mays L.) in modern agriculture is fundamental and multidimensional, covering economic, food, feed and industrial aspects at a global level. Maize is one of the three staple cereals (along with wheat and rice) and usually ranks first or second position in the world in terms of cultivated area and total recorded production. A modern technology for maize cultivation in the context of climate change focuses on resilience, resource efficiency (especially water and nutrients) and risk reduction by integrating advanced genetics with conservative and digital farming practices. The main strategies aim to combat the negative effects of climate change, such as prolonged drought, heatwave (extreme temperatures during the critical flowering phase) and extreme weather events (hail, torrential rains and so on). The minimum tillage or no-tillage system has a complex and variable influence on the productive capacity of maize, being dependent on factors such as soil type, climatic conditions (especially precipitation regime), and crop management (e.g., herbicides applied, fertilization management). The preliminary data from this work show the multiple influence of vegetation factors on the emergence, growth and development of corn plants, but also on the expression of productive potential in the argic chernozem conditions at ARDS Caracal. The yields obtained under non-irrigated conditions ranged from 3082 kg/ha in the control variant (classic plowing) to 4487 kg/ha in the variant sown directly in stubble to which the ICDPP biostimulator was applied.

Key words**:**minimum tillage; maize; biostimulator; yield;

INTRODUCTION

In a modern agriculture, minimum tillage is more than just a cost-saving measure, it is a strategic response to climate change and the need for sustainable food production. In 2025 year, the adoption of these practices is driven by significant improvements in soil resilience and farm profitability (https://www.kuhn.co.uk). According to Farmonaut platform (www.farmonaut.com) the agriculture enters a new era shaped by sustainability and technological innovation, till vs no till farming remains a central conversation in modern farming communities worldwide. With 2025 ushering in increasing awareness of climate impact, soil health management, and resource conservation, farmers, researchers, and policymakers are evaluating the best methods to ensure high productivity and sustainable environmental outcomes.

The most powerful impact of minimum tillage is the restoration of the soil's natural ecosystem, which is often destroyed by traditional plowing. Main advantage of such systems is represented by:

- ✓ *Massive erosion reduction:* minimum tillage can reduce soil loss by up to 90%. By keeping crop residue on the surface, the soil is shielded from wind and heavy rain "splash" erosion;
- ✓ *Carbon sequestration:* it is a key tool for "Carbon Farming." By not inverting the soil, organic matter is preserved rather than oxidized into the atmosphere. This can increase soil organic matter by 0.2% per year, aiding in climate change mitigation;
- ✓ *Water infiltration and retention:* the undisturbed soil structure maintains natural pores (created by old roots and earthworms). This allows water to soak in deeper and faster, reducing runoff and keeping the crop hydrated during dry spells.

Also, a transition to the minimum till or no till system can reduce fuel consumption by 40–50% because it requires fewer passes over the field. This also extends the life of expensive tractors and equipment.

Jiang Xiaodong et al, 2007, studied the effects of minimum tillage and no-tillage on crops yield and crops water use efficiency (WUE) under the condition of winter wheat relayed with summer maize cultivation. Results obtained showed that minimum tillage especially rotary tillage with straw returned, could increase soil water content, crops WUE and crops yield of a whole year. Preliminary studies showed that rotary tillage with straw turnover could be adopted in this region, while no-tillage with straw cover returned was not suitable.

Sharma Peeyush et al., 2009, in a study related the influence of tillage and mulching management on soil physical and chemical properties and crop yield on maize-wheat system under rainfed situations concluded that the maize and wheat yield was statistically at par in conventional and minimum tillage and significantly higher over control. Also, reduction in infiltration rate was 17.24% higher in conventional tillage than minimum tillage. Minimum tillage improved the net return, benefit: cost ratio as well as fertility status.

The influence of fertilization and complementary agricultural practices on crop performance remains a critical area of inquiry for sustainable food and bioenergy production. Thus, fertilization practices play a decisive role in shaping crop yield and resilience to disease (Paraschivu et al., 2011; Partal and Paraschivu, 2020; Drăghici et al., 2021; Matei et al., 2021; Partal et al., 2023).

The results from the specialized literature also highlight a series of negative aspects of the minimum tillage system on maize crop, such as:

- ✓ *risk of compaction* in heavy clay soils;
- ✓ *soils stay colder* and wetter in early spring;
- ✓ *high upfront cost* for specialized equipment;
- ✓ *potential yield dip* (3–5%) in the first 2–3 years.

Extending new tillage systems, conservative systems specific to conservative sustainable agriculture, is a difficult task to accomplish under the circumstances of strong dicotyledonous perennial weed infestation. In a study made on tree species: wheat, maize and soybean, Rusu T. et al, 2013, showed that the use of minimum tillage systems caused, at the end of a 3-year crop rotation, the increase of the *Convolvulus arvensis L.* pervasion in all three crops:

11.2-39.1% for soybean, 0.9-4.2% for wheat, and 11.9-24.4% for maize.

Similar results were observed by Chetan F. et al, 2020, in a research of 12 years (2007 – 2018) about the influence of the tillage system on weeds and maize yields, in different pedoclimatic conditions of Transylvanian plain. According to the author's conclusionsthe total number of weeds in MT was higher (343 pcs. m(-2)) than CS (324 pcs.m(-2)), because, without soil inversion, weed seeds remained in the soil surface layer and climate conditions stimulated weed germination. The cultivation of maize in minimum tillage system could be recommended as a viable alternative to the classical system in the hilly area from Transylvania, this recommendation is also based on the rather small quantitative differences (133 kg ha(-1)) between the two tillage systems. Shah, Muhammad Aqeel et al., 2011, in a study conducted in 2011-2012 at research area of soil and environmental sciences, University of Agriculture, Faisalabad in randomized complete block design (RCBD) having three treatments of minimum tillage (MT), conventional tillage (CT) and deep tillage (DT) with three replicates to evaluate the performance of Maize (Zea mays L.) yield attributes and absorption of different nutrients under various tillage strategies. Maximum effect of tillage practices was observed in the CT and DT that gives the maximum number of leaves, plant height, plant biomass as well as straw yield. The effect of different tillage practices on the harvest index of maize crop was significant. The grain yield of maize was more in case of DT (7.24 t/ha^{-1}) as compared to CT (7.22 t/ha^{-1}) and MT (6.44 t/ha^{-1}).

Botos L.F. et al., 2025, in the area of clay soils in the west of Romania realized a research aimed to optimize the tillage system and test the performance of some maize hybrids in the context of climate change, comparing two tillage - minimum and conventional tillage systems - in terms of the impact on average production. The results obtained show that the minimum tillage system led to an increase in average production by 1.117 kg/ha compared to the conventional system. In the dry year 2022, the difference was 603 kg/ha, and in 2023, more climatically favourable, the difference was more pronounced, reaching 1.608 kg/ha.

MATERIALS AND METHODS

Taking in account the variety of the results, sometimes with opposite results related the influence of the tillage system to the capacity of productivity of maize, we start a study in the conditions of climatic conditions from the Agricultural and Development Research Station from Caracal (ARDS Caracal), on chernozem, in non-irrigated conditions, in the spring of 2025. The experimental design has 5 variants, as follow (figure 1):

V1 – conventional plowing at 25 cm depth; V2–conservative system; V3 – conservative system + soil biostimulator from ICPA; V4 – conservative system + soil biostimulator from INMA; V5 – conservative system + soil biostimulator from ICDPP.

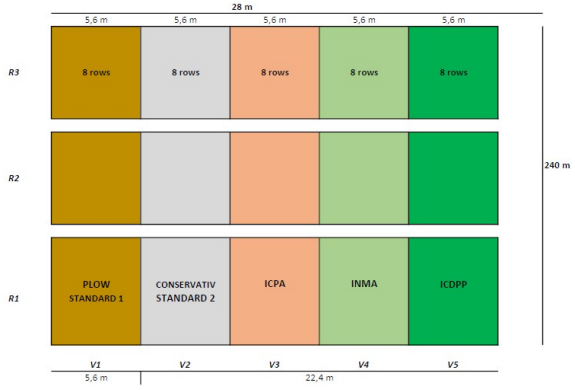


Figure 1. Experimental design at ARDS Caracal

As background fertilizer was applied a quantity of 250 kg/ha of mineral fertilizer product 25:25:0 (NPK), equal on each variant before the tillage.

Before sowing were applied 200 kg/ha dihydrate calcium sulphate ($CaSO_4*2H_2O$)in order to create good conditions for high activity of the microorganisms at the maize roots level.For this phase we use a mechanical equipment – prototype INMA (Figure 2) – the scarifier equipped with equipment for inoculating microorganisms biostimulator into the soil.

Figure 2. Scarifier equipped with equipment for inoculating microorganisms biostimulator into the soil

Figure 3. Precision seed drills for direct sowing in uncultivated soil

All biostimulators used are in the developed stage, not approved and are not available on the market, they will need to be certified, approved and marketed after testing. Their formulas are based on selected bacterial strains and extracts from natural products.

The maize genotype used was early hybrid ES MYLADY from FAO Group 340. The density used was 60 000 seeds/ha. Also, for this phase we use a prototype of precision seed drills for sowing in uncultivated soil (figure 3).

During the vegetation period of maize, the weed control was ensured by herbicide Elumis, applied in postemergence of maize – 4-6 leaves, in dose of 1.5 l/ha.

The collected data were processed using ANOVA programme.

RESULTS AND DISCUSSIONS

From a climatic point of view, the year 2025 was a particularly hot one, with large temperature fluctuations and amplitudes, especially in the months of June, July and August (figure 4).

The maximum temperatures for these months were over 40 degrees Celsius: 40.3°C in June, 42.3°C in July and 41.6°C in August. Not only did these values negatively influence the corn production capacity, but also the number of consecutive days with temperatures over 40 degrees Celsius: 3 days in June, 7 days in July and 4 days in August.

Figure 4. Thermal regime in 2025 on the conditions of 2025 (ARDS Caracal)

The rainfall regime was also fluctuating, especially in the period preceding sowing, with low values during the cold period,

with January and February accumulating only 4.4 mm and respectively6.4 mm. The same trend was maintained in March and April (figure 5).

Figure 5. Rainfall regime in 2025 on the conditions of 2025 (ARDS Caracal)

Those 22 mm precipitations that fell in April were enough for the classic variant to sprout evenly, but the variants sown in the conservative system sprouted more slowly and relatively unevenly. However, they recovered in May when the sum of the precipitations reached 104.6 mm, which allowed the plants from these variants to recover their vegetative development, approaching the plants in the classic variant in terms of stagedevelopment.

The hot summer months, when corn plants had the maximum water requirement, but also the highest level of evapotranspiration (ETO), had a negative influence on the growth rate, but especially during the flowering period, some of them, especially the plants in the classic plowing variant, ended their vegetation prematurely, in the first decade of August, which considerably reduced the productive capacity of the tested hybrid in the pedoclimatic conditions at ARDS Caracal. *Plant's height* – had values between 200 cm at variant V4 and 236 at V1 – classic plowing (figure 6). Due the facts above described on the climatical evolutions of the factors heat and rainfall regime, the highest plants were registered on V1 variant, with another features, a high uniformity of the plants at maturity.

On the variants with minimum till systems (V2-V5) the registered differences between plants were small, ranged between 200 cm at V2 variant and 212 cm at V5 variant, which recorded the highest plants from the variants with minimum tillage systems.

Figure 6. Plant's height and number of leaves/plant in the conditions of 2025 (ARDS Caracal)

On maize, *the number of leaves/plants* is a character influenced especially by the geographical latitude, maize being a species with an obvious response to the area of cultivation on the globe (Matei Gh. 2013). From this point of view, in our conditions we observe a small difference between variants, with values that range between 13.4 leaves/plant on the variants V2 and V4 to 14.4 leaves/plant at V5. In variant V1 – used as standard, the average value was 13.6 leaves/plant. Another determination made in field conditions was *the number of cobs/plant* (figure 7).

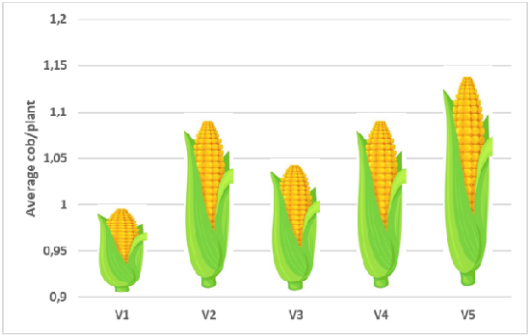
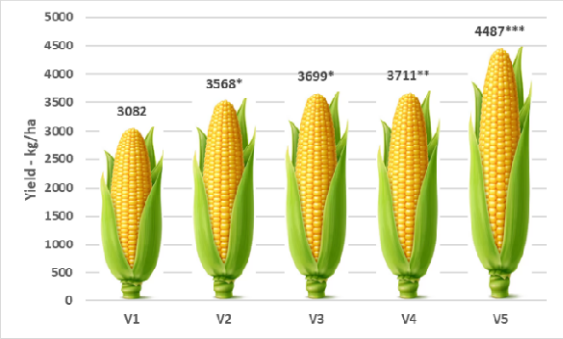


Figure 7. Average number of cobs/plant in the conditions of 2025 (ARDS Caracal)

From this point of view, it can be observed in figure 7 that the value of the character was at all variants seeded in conservative system higher than the classical plowing variant. Comparing the results registered on this character with those from the literature about the ES MYLADY hybrid, due the very hard conditions from the climatic point of view, we conclude that the hybrid was unable to express its productive potential to the fullest capacity.

The registered yields in the two systems tested ranged between 3082 kg/ha on the variant with classical plowing used as standard and 4487 kg/ka at variant V5 in minimum tillage system + soil biostimulator ICPPD (figure 8).



DL 5%=374 kg/ha; DL1%=621 kg/ha; DL 0,1%=975 kg/ha

Figure 8. Maize yields in the conditions of 2025 (ARDS Caracal)

The increases in production recorded at variants V2 and V3, of 486 kg/ha and respectively 617 kg/ha, were considered as significant, statistically point of view.

The yield of the V4, of 3711 kg/ha, had an increase in production of 629 kg/ha, also ensured as distinct significant in comparison with the standard used, the V1 variant.

The highest difference related the V1, of 1405 kg/ha, was obtained at variant V5 which was appreciated as very significant, from statistically the point of view.

After the harvest, we made in laboratory some *determinations on cobs* sample retracted from each variant (figure 9).

The *number of rows/cobs* had a small amplitude between the variants from the minimum tillage system and ranged between 16 rows/cob on the variant V2 to 16.4 to variant V5. The standard, classical plowing (V1) has registered a number of 14 rows/cob, having the smallest value on this character.

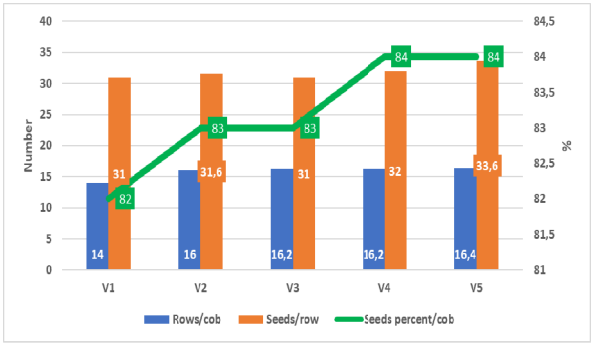


Figure 9. Biometric measurement on maize cobs in the conditions of 2025 (ARDS Caracal)

Number of seeds/rows was also recorded in the laboratory determinations and varied between 31 seeds/row at V1 and V3 variants till 33.6 seeds/row at V5 variant. With a closer value to this, the variant V4 is highlighted with 32 seeds/row.

We determinate also the *percentage of seeds from the total weight of cobs*. Usually, at maize hybrids, the percentage of seeds ranged between 75% to 85%, depending of the hybrid's FAO group and some technological aspects: density, nutrient's management, water regime on crop and so on.

In our case, the percentage of seeds from the total weight of cobs had values between 82% at variant V1 to 84% at variants V4 and V5. Those closer values were explained by the hard particular climatic conditions from this year, with an

unfavourable thermal regime for maize crop in the South-West part of Romania.

The mass of 1000 seeds (figure 10) on the ES MYLADY hybrid, tested in the conditions of argic chernozem from the ARDS Caracal in 2025, had lowest value of 266 grams/1000 seeds on variant V1 (classical plowing – standard). At the opposite side, the highest value for this parameter was recorded at variant V5, of 338 grams/1000 seeds. Also, in the case of this indicator the values obtained shows us the highest values in the system of minimum tillage compared with the classical one.

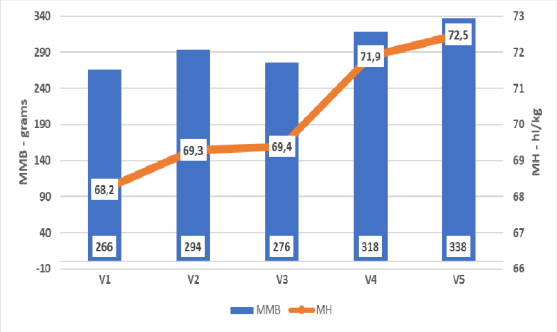


Figure 10. Average MMB and MH on maize in the conditions of 2025 (ARDS Caracal)

In the agricultural industry, *hectolitric weight* (also known as test weight or specific weight) is a key measure of the bulk density of grain. For maize (corn), it represents the weight of the grain required to fill a 100-liter container (one hectolitre).

Results recorded in our experiment place the corn production in the normal quality class which include values between 68 kg/hl to 72 kg/hl. The most valuable variant proved to be V5, with a value of 72.5 kg/hl.

CONCLUSIONS

Choosing the right tillage system for maize (corn) involves balancing soil health, moisture retention, and economic costs against potential yield risks.

While conventional tillage was the gold standard for decades, Conservation Tillage (No-Till, Strip-Till) has gained massive popularity due to its ability to combat erosion and reduce fuel and labour costs.

Even in our case, when the experiment just started in 2025, in very particular climatic conditions, some conclusions can be drawn based on the results of this year, as follows:

- ✓ soil tillage system for maize had a powerful influence to the entire vegetative period of the plants, their capacity to grow, on the ability to develop adequate leaf area with a 4-5 index and also to the capacity to generate good yields;
- ✓ some technical aspects as sowing date and length of maize BBCH stages were directly controlled by the thermal evolution in the area of ARDS Caracal;
- ✓ in the very difficult conditions of an year with large amplitudes of precipitation distribution during the corn growing season the minimum tillage system proved to more adapted to these conditions, even in the main early stages, the classic plowing system seemed superior to the minimal tillage system.
- ✓ from the three biostimulators under development, the most suitable for the conditions of the Caracal Plain proved to be that developed by ICDPP which conduct to highest yields, of over 4487 kg/ha.

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