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# STUDIES ON THE CHOICE OF THE HYBRID, AN IMPORTANT LINK IN THE TECHNOLOGICAL MANAGEMENT OF THE CORN CROP AND ITS ECONOMIC EFFICIENCY, ACCORDING TO THE TESTS CARRIED OUT ON THE CHERNOZEM SOIL FROM CARACAL, OLT COUNTY, ROMANIA

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***Abstract***

*In the period 2020-2023, on the chernozem from Caracal, numerous corn hybrids of different origins and with vegetation periods placed in almost all FAO precocity groups were tested. In 3 of the 4 years of testing, production stability was average (CV 13.4% in 2020, 15.9% in 2021 and 17.3% in 2022). Following the boxplot analysis the hybrids P0710 (Corteva) and Kashmir (KWS) stood out as positive outliers in 2021 and MAS 448 (Mass Seeds) in 2023. Although an average of 70 hybrids were tested annually, their production average was extremely close in years with favorable climatic conditions (6,654 kg/ha in 2020, 6,603 kg/ha in 2021, 6,795 kg/ha in 2023). The studies highlighted: the adaptability of a very large number of hybrids for the chernozem area in Olt County; average production stability; the rich assortment of hybrids offered by large seed companies. The economic efficiency in the case of choosing the hybrid is primarily influenced by the production obtained per hectare, by its capitalization price, but also by the price of the sown seed and the bonuses garanted by the producing company. In the last 2 years, the low prices practiced in capitalizing the production have made the option for the better hybrid which brings profit.*

***Key words*:** *hybrid, maize, cultivation technology, economic efficiency*

## INTRODUCTION

One of the most widespread plants cultivated and used for both human and animal consumption is maize [1, 10]. This plant is one of the most adaptable crops, with a great diversity of hybrids that can be found in all corners of the world and in many climatic and soil conditions [19]. The large productions of grains or green mass, together with a great diversity of its valorization, through various processing methods, have determined that this crop, along with wheat and barley, is among the most important components of economic and development programs [21].

The global production of corn annually exceeds that of any other grain globally. 11,635 million tons of grain corns are produced annually from an area of 203 million hectares, which represents an average yield of 5,700 kg/hectare [9].

In our country, maize corn is highly cultivated due to the high productivity per surface unit [20]. In Romania, the area cultivated with corn is between 2.5-3.1 million ha depending on the rainfall in the cold season [22]. Maize is one of the most adaptable plants. A wide range of hybrids can be cultivated worldwide. [2, 5].

The continents where the largest areas of corn are cultivated are America, Asia, Europe and Africa. At the global level, the largest producer of corn is America with a share of over 50% of world corn production, followed by Asia with over 30% of total corn production. Europe

ranks third with a production share of over 11% of the total world corn production [5]. In national agriculture, the corn culture is spread throughout the country, occupying the first place on a national level, surpassing the wheat culture. According to FAOSTAT data, Romania has the largest area cultivated with corn in Europe, being among the top 10 corn exporting countries globally.

In Romania, 76% of the surface of the agricultural territory, the thermal factor is favorable and very favorable for the cultivation of corn, which can ensure high harvests. Suitable areas for corn cultivation are grouped according to the sum of biologically active temperatures (sum TBA), which exceed the limit of 10°C, into six favorability regions [18]. In order to effectively capitalize on the potential of the area, special attention must be paid to the choice of maize hybrids according to earliness and the requirements of each one in relation to climate and soil conditions.

Now that the weather conditions are more and more variable, from year to year, without increasing the consumption of water and fertilizers, an important role is played by the seed used to establish crops, which through its biological, physical and physiological qualities can grow harvest without having a negative influence on the environment and people's health [21].

Choosing the best corn hybrid for your own farm is not an easy job if the farmer is very interested in the investment he makes in the spring and the profit he should make in the fall. Usually farmers are fans of hybrids of one company. From the list of the respective company's products, depending on the cultivated area, the farmer chooses between 1 and 4 hybrids. In certain cases, a small percentage of the surface is allocated to another company's corn hybrid. This way of choosing the genetic base will further affect production and profitability. Moreover, the fact that the farmer chooses the hybrid on an emotional basis and is loyal to a company has and will continue to affect the price charged in the market by the big players. For this reason, it is necessary for the farmer to have as many benchmarks as possible when choosing a certain hybrid of corn, having to set some targets depending on the technological possibilities of the farm and the pedo-climatic conditions.

A recent and very complex study from the USA clearly demonstrated how important the choice of corn hybrid/genetics is, this aspect taking the 3rd place, after weather and fertilization. Choosing the right hybrid is responsible for at least 20% of production. So, it matters more than most farmers expect [6].

Maize is characterized by a current average increase in genetic progress of about 1% and a yield range of between 30% (Iowa) and over 200% (sub-Saharan Africa). A lot of factors can reduce profit: infrastructural and institutional constraints what's going on farm costs and prices, farmers' skills, various technical constraints. There may also be mistakes in the efficiency of input use, which no longer lead to improved management of crops and resources on the principle - more with less [8].

Genetic transformation and biotechnology represent the optimal solution for transitioning from hybrids obtained by conventional breeding, to supercompetitive ones in terms of drought tolerance and induced resistance to insects and pathogens [3, 7]. Plant breeding, using the combined potential of conventional, molecular and genetically engineered technologies, will provide hybrids with increased nutrient and water use efficiency, increased heat and drought tolerance, disease resistance and adequate end-use and nutritional quality and, perhaps most importantly, the increased ability to cope with the extreme increases in temperature and precipitation that occur in a place over the years. Hybrids developed by seed companies, international crop research centers, and national breeding programs often show very broad geographic adaptation as well as wide adaptation to a range of environmental and management conditions. To identify such hybrids, testing in various locations conducted by the International Maize and Wheat Improvement Center (CIMMYT) and the International Rice Research Institute (IRRI) remains the most effective system. International evaluation networks based on the exchange and free access to germplasm and multi-site testing are ways to select the wheat,

rice and maize germplasm that is best adapted to the increasingly variable growing conditions encountered due to climate change global [4].
Currently, the economic evaluation of crop cultivation technologies under market conditions is extremely important. In recent years, the prices of fertilizers, pesticides, diesel and other energy resources have increased significantly. Thus, there is an impact on the increase in corn production costs and, consequently, on the decrease in sales revenues [25]. That is why the development of corn cultivation technologies and resource-saving technologies is primarily aimed at ensuring maximum profit with sufficient cost recovery [11, 15].
However, in general, the economic effect of corn cultivation it is set by the free market, by the government's agricultural policy on cereals development industry, by the resource efficiency of the implemented culture technologies and by level and quality of the products [13, 16, 12].

In this context, the purpose of this research was to test, on the chernozem from Caracal, numerous corn hybrids of different origins and with vegetation periods placed in almost all FAO precocity groups in the period 2020-2023, in order to evaluate yield potential.

## MATERIALS AND METHODS

The corn hybrids came from globally recognized companies – BASF, BIOCROP, CORTEVA, DONAU SAAT, KWS, LIDEA, MAS SEEDS, SAATEN UNION, and SYNGENTA.
Starting from the fact that the hybrids were tested under the same technological conditions, as presented in Table 1, the income per hectare and % seed cost of the income for a density of 70,000 plants/ha was calculated according to the price of the dose for each hybrid and of the number of germinating grains in each dose (50,000 g.g or 80,000 g.g).

Table 1. Technology applied to corn lots

| **Technological work** | **Testing year** | | | |
|---|---|---|---|---|
| | **2020** | **2021** | **2022** | **2023** |
| -Pre-crop | Sunflower | Sunflower | Sunflower | Colza |
| -Plowing | In autumn | | | |
| -Disc work | 30.03.2020 | 31.03.2021 | 24.02.2022 | 23.02.2023 |
| -Fertilization: | NUTRITOP – 150 kg/ha 04.04.2020 | NPK 20:20:0 – 250 kg/ha 01.04.2021 | NPK 20:20:0 – 250 kg/ha 15.04.2022 | NPK 20:20:0 – 250 kg/ha 08.04.2023 |
| -Combinator: | 06.04.2020 | 15.04.2021 | 15.04.2022 | 13.04.2023 |
| -Sowing date: | 06.04.2020 | 16.04.2021 | 16.04.2022 | 20.04.2023 |
| -Emergence date: | 20.04.2020 | 02.05.2021 | 24.04.2022 | 30.04.2023 |
| -Pre - herbicide | TENDER 1.5 l/ha 07.04.2020 | SPECTRUM 1.4 l/ha 17.04.2021 | SPECTRUM 1.4 l/ha 16.04.2022 | GARDOPRIM 4.5 l/ha 20.04.2023 |
| -Post herbicide | EQUIP 2 l/ha MUSTANG 0.5 l/ha KERAFOL 1 l/ha EVOGEL 3 kg/ha WETCIT 0.25 l/ha KAISO SORBIE 0.25 l/ha 14.05.2020: | DICOPUR 1 l/ha NOVAPOWER 1.3 l/ha 22.05.2021 | ELUMIS 2 l/ha 19.05.2022 | ELUMIS 2 l/ha 3.06.2023 |
| -Fertilized | UREE NG 150 kg/ha 26.05.2020 | Ammonium nitrate 07.06.2021 | Ammonium nitrate 28.05.2022 | Ammonium nitrate 07.06.2023 |
| -Harvested | 24.08.2020 | 14.09.2021 | 29.08.2022 | 12.09.2023 |

Source: Own experiments.

The correct choice of a hybrid is given by the relationship income - % seed cost from income in the sense that at high income, the % must be lower under the conditions in which the technology applied is identical for all the hybrids analyzed, as it was in the presented experiment.
The low prices practiced in the last 2 years on the corn market are not edifying for the calculation of profit and that is why the

correlation between income and % seed cost of income/ha was used.
From a climatic point of view, the years 2020, 2021 and 2023 were favorable for corn cultivation, but the year 2022 was extremely dry and the hybrids placed in the FAO 400 group practically did not have productions above 500 kg/ha.

## RESULTS AND DISCUSSIONS

The studies highlighted: the adaptability of a very large number of hybrids for the chernozium area in Olt County; average production stability; the rich assortment of hybrids offered by large seed companies.
The extremely unfavorable climatic conditions of the year 2022 meant that the corn in the FAO 400 group did not produce grains except in very small quantities, the results being very flawed. Therefore, this data will not be taken into account in the interpretation. Also noted is the very low recovery price of corn in these test years. The limits of % seed cost of income is extremely variable (Table 2).
In 3 of the 4 years of testing, production stability was average (CV 13.4% in 2020, 15.9% in 2021 and 17.3% in 2023). The average stability of hybrids (tests with hybrids of LNZ GROUP from Ukraine) was also highlighted by [24].
Although an average of 70 hybrids were tested annually, their production average was extremely close in years with favorable climatic conditions (6,654 kg/ha in 2020, 6,603 kg/ha in 2021, 6,795 kg/ha in 2023) (Table 3).
It is all the more important knowing that hybrids from all FAO groups and from the main seed companies have been tested. As mentioned before, the year 2022 should not be taken into account given the unfavorable climatic conditions for the maize crop.

Table 2. Synthesis of the percentage of seed cost of income realized/ha in the test years

| The year | Yield min/yield max (kg/ha) | Selling price (lei/kg) | Limits % seed cost of income | Companies with low % seed cost | Companies with high seed cost % |
|---|---|---|---|---|---|
| 2020 | 4,275/8,539 | 0.61 | 7.3-27.4 | DSR 10.5-11.6<br>MAS SEEDS 7.3-13.2<br>SU 8.0-12.5 | CORTEVA 15.4-27.4 |
| 2021 | 3,421/9,316 | 0.92 | 6.3-23.6 | MAS SEEDS 6.3-8.4<br>BIOCROP 8-9.8<br>KWS 8.7-12.1 | LIDEA 10.6-23.6 |
| 2022 | 100/1,943 | 0.93 | 24.2-103.5 | BASF 63.4-94.5<br>KWS 29.6-101.5<br>DSR 24.2-103.5 | CORTEVA 52.7-554.9 |
| 2023 | 4,222/9,951 | 0.805 | 6.7-33.9 | BIOCROP 6.7-9.6<br>KWS 7.2-11.6 | CORTEVA 14.5-33.9 |

Source: Own results.

Table 3. Coefficients of variability of production recorded in hybrids tested at Caracal

| The year | No. tested hybrids | Average of yield (kg/ha) | CV (%) | CV interpretation |
|---|---|---|---|---|
| 2020 | 65 | 6,654 | 13.4 | medium stability |
| 2021 | 71 | 6,603 | 15.9 | medium stability |
| 2022 | 78 | 1,120 | 40.0 | instability |
| 2023 | 76 | 6,795 | 17.3 | medium stability |

Source: Own results.

Similar research was carried out by Oltenacu and collaborators in 2023, at the Moara Domnească Station near Bucharest [17]. The SC4140 hybrid was noted which, under non-fertilization conditions, was superior in terms of production to the P9903 hybrid. Other studies made during the period 2018-2020 have shown that yield of corn hybrids, on average varied from 4.39 t ha-1 in the control variant to 6.65 t ha-1 - with the application of

N135P90K125 + N60 + N30 in two stages. The lowest income (4,573 lei/ha) was recorded in the non-fertilized variant, the highest (8,685 lei/ha) was obtained in the variant which the 150 kg nitrogen/ha, profit increased from 4,395 lei/ha at 6,694 lei/ha. In the 2021, although the yields were similar, the selling price influenced the financial result, they being lower [14]. The economic efficiency in the case of choosing the hybrid is primarily influenced by the production obtained per hectare, by its capitalization price, but also by the price of the sown seed and the bonuses granted by the producing company. In the last 2 years, the low prices practiced in capitalizing the production have made the choice of the hybrid essential in obtaining the profit. The data related to the selling price of the seed for this study were taken from the offers of the distributing firms and it refers strictly to the listed price.

The results were presented for each year separately, highlighting the hybrids at the extremes of the correlation between income/ha and % seed cost of income.

In 2020, the Berlioz and Lukaku hybrids fulfilled the condition that at a high income/ha, the part covering the cost of the seed is small (Figure 1).

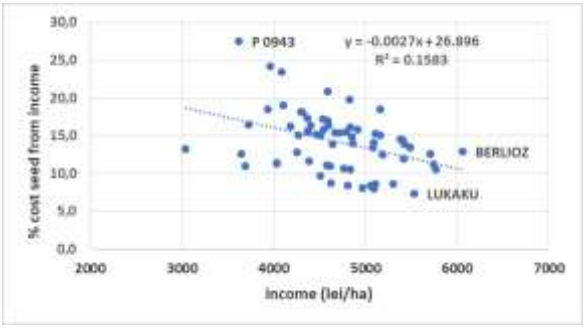


Fig. 1. The relationship between income per hectare and % seed cost of income/ha in the hybrids tested on the Caracal chernozem in 2020.
Source: Own design and calculation.

On the opposite side was the hybrid P0943 with a seed cost of over 25% of the income. In general, the hybrids of the Corteva company, because they have high prices and their productions do not differ much from the others even if they are fruitful, are not profitable in the conditions of Caracal. In this year, only 15% of the variability of income /ha determined the variability of the other character studied (Figure 2).

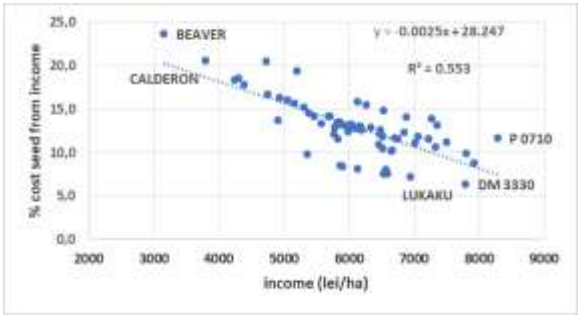


Fig. 2. The relationship between income per hectare and % seed cost of income/ha in the hybrids tested on the Caracal chernozem in 2021.
Source: Own design and calculation.

In 2022, as expected, Corteva hybrids were the most unprofitable because productions were extremely low and their price is high. The fairly high coefficient of determination (49%) shows the interdependence of the variability of the 2 characters even under unfavorable climatic conditions (Figure 3).

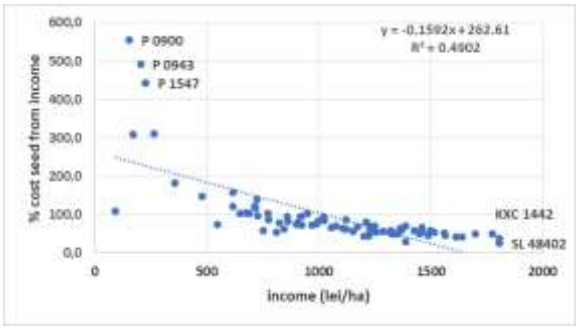


Fig. 3. The relationship between the income per hectare and % seed cost of the income/ha in the hybrids tested on the chernozem from Caracal in 2022.
Source: Own design and calculation.

In the year 2023, the Inteligens and MAS 440 D hybrids met the condition that at a high income/ha, the part covering the cost of the seed is small, even 10% for the first hybrid. The hybrids Corteva P9944, P0217 and P9975 were not so productive that the % seed cost of the income per hectare were low but between 30-35%. In this year 41% of the variability of income /ha determined the variability of the cost, also a rather high coefficient of determination (Figure 4).

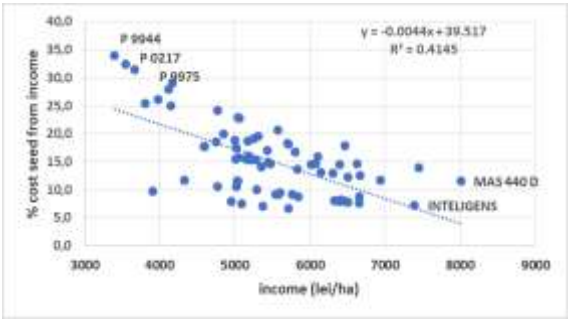


Fig. 4. The relationship between the income per hectare and % seed cost of the income/ha in the hybrids tested on the chernozem from Caracal in 2023.
Source: Own design and calculation.

Research by Hryhoriv et al. in 2022 showed that the bigger economic efficiency of maize cultivation was recorded at N135P90K125+ N60+N30 variant with a plant density of 60,000 plants ha–1, profitability index – 135%, being the highlest. The lowest profitability index was in the variant with the plant density of 80,000 plants ha–1 without mineral fertilizers - 53%. [14].
Other research showed that in 2 different systems: conventional and non-till, Adevai and LG 3232 hybrids reported the best economic efficiency [23].
However, in order to highlight the most productive or the weakest of the hybrids tested, the boxplot method was used. The hybrids P0710 (Corteva) and Kashmir (KWS) in the year 2021 and MAS 448 (Mass Seeds) in the year 2023 were noted as positive outliers, following the analysis by the boxplot method (Table 4).

Table 4. Highlighting productive or less productive hybrids using the boxplot method

| **BOX PLOT** | **2020** | **2021** | **2022** | **2023** |
|---|---|---|---|---|
| MIN | 4,275 | 3,421 | 100 | 4,222 |
| Q1 | 6,085 | 5,970 | 803 | 6,223 |
| MEDIAN | 6,591 | 6,613 | 1,146 | 6,682 |
| Q3 | 7,223 | 7,220 | 1,461 | 7,658 |
| MAX | 8,539 | 9,316 | 1,943 | 9,951 |
| AVERAGE | 6,654 | 6,616 | 1,120 | 6,795 |
| IQR | 1,138 | 1,250 | 658 | 1,435 |
| LOWER LIMIT | 4,379 | 4,094 | -183 | 4,070 |
| UPPER LIMIT | 8,930 | 9,096 | 2447 | 9,811 |
| OUTLIER POZITIV | | P0710 KASHMIR | | MAS 448 |
| OUTLIER NEGATIV | MAS 56A | BEAVER | | |

Source: Own results.

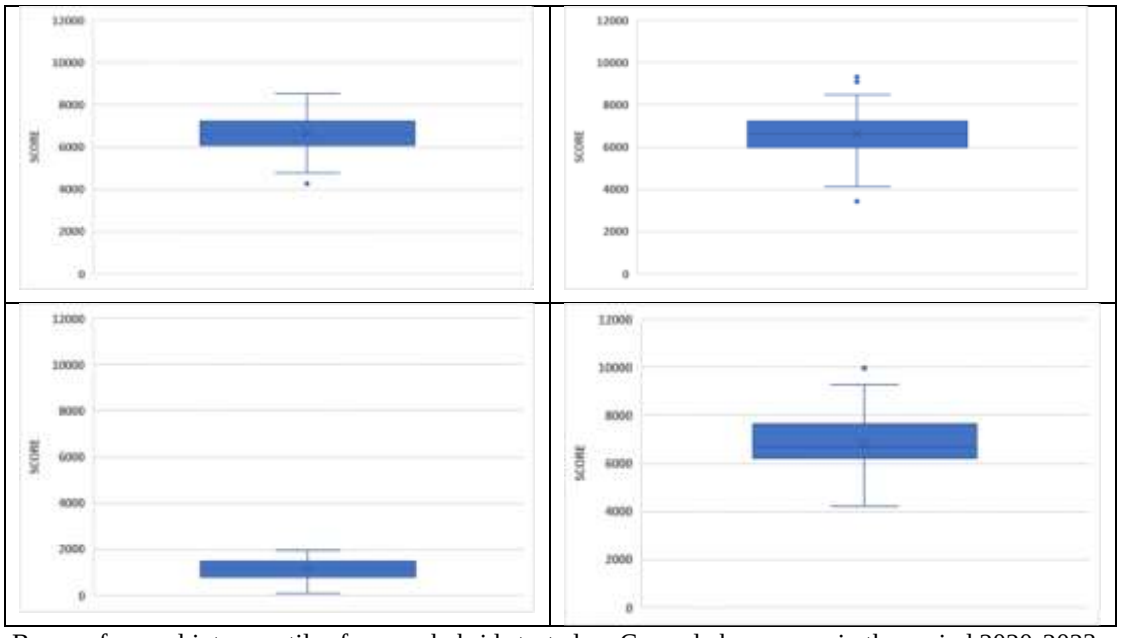


Fig. 5. Boxes of annual interquartiles for corn hybrids tested on Caracal chernozem, in the period 2020-2023
Source: Own design and calculation.

Figure 5 shows the almost identical adaptability of hybrids from the years 2020 and 2021 to the pedoclimatic conditions of Caracal, but also the greater share of 50% of the productions of the corn hybrids from the year 2023 as well as the narrow interquartile range from 2023 when the differences between the productions were practically reduced due to the drought.

## CONCLUSIONS

In the conditions of Caracal, during the analyzed period, the % seed cost of the income per hectare was chosen as an indicator of economic efficiency, because the same technology was used in the hundreds of tested hybrids in each of the years of testing. Also, the unstable market against the background of the disruption of the world socio-economic context did not allow profit to be obtained in these years.

However, following the interpretation of the correlation between the obtained income and % seed cost of the income/ha, the one that led to the correct choice of the hybrid, the following were favorably noted: the Lukaku, Berlioz, DM 3330, P 0710, KXC 1442, SL 48402, MAS 440D, Intelligence.

The companies BIOCROP, KWS SEMINTE and MAS SEEDS stood out in at least 2 years out of 4 years of testing, from the point of view of reduced costs with seeds from revenues.

Strictly speaking of yield, through the boxplot method, the P0710 (Corteva) and Kashmir (KWS) hybrids in 2021 and MAS 448 (Mass Seeds) in 2023 stood out as positive outliers.

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