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MAIZE CULTURE - AN INTENSIVE OR EXTENSIVE PRODUCTION SYSTEM IN ROMANIA

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Abstract

The paper aimed to analyze the dynamics of maize production in Romania and the influence of cultivated area and maize yield on this output, using the empirical data provided by the National Institute of Statistics for the period 2007-2015. The analysis is based on various methods like the chained substitution of factors, and fixed indices, coefficient of correlation and determination, and regression function. In the analyzed period, the cultivated area with maize increased by 3.12 % reaching 2,604 thousand tons in 2015. Romania potential to produce maize is about 12,000 thousand tons, placing the country among the top producers in the EU-28. Maize is the most important cereal crop contributing by 47 % to cereal production. In 2015, maize yield accounted for 3,449 kg/ha being by 126 % higher than in 2007, but tge performance is still very low compared to other EU countries. The main changes in maize production were determined by average maize production ($r = 0.968$ and $R^2= 0.9386$), and in a weak measure by cultivated surface ($r = 0.080$ and $R^2=0.0065$. The same aspect relationships were confirmed by the regression functions between these indicators. As a conclusion, maize yield is the key factor increasing production. Maize culture is cultivated in an intensive production system in Romania. Farmers should be on the factors supporting production growth as follows: to use high value certificated maize seeds from hybrids with a higher production potential, to apply the corresponding agricultural works according to the modern technologies, to take into account the need of crop rotation, to assure the corresponding plant density per unit of surface, the adequate doses of fertilizers, to take care of pest control, to assure irrigation and also to assure the insurance of maize culture against climate phenomena. Maize production is important for internal consumption and also for export.

***Key words*: *Key words**: maize crop, cultivated area, maize yield, maize production, Romania*

INTRODUCTION

Agriculture is very important for assuring food for population and a high life quality and living standard.

Agricultural systems are functional units including the natural and social-economic framework created for obtaining vegetal and animal production under the management and control of the farmer, in order to obtain high production performance and economic efficiency.

Intensive production system in agriculture requires important inputs such as: large agricultural land surface, high quality certificated seeds, modern machinery, fertilization, pesticides, irrigations, labour, fuel, etc to assure high qualitative and qualitative production, a high economic efficiency and competitiveness [1].

Besides wheat and rice, maize is an important human food resource, accounting for 94% of all cereal consumption at world level [5].

Maize is an important cereal proving high nutritional value food products for human and animal consumption. Of 100 kg maize grains it could be obtained77 kg maize flour, 63 kg starch, 44 l alchool, 71 kg glucose, 1.8-2.7 l oil and 3.6 kg maize cake.

Maize has a high production potential, by 50 % higher than the other cereals. It is able to porduce constant harvests, it is good in monoculture for many years, a good prior plant for most of crops, and its cultivation is mecanisable 100 %, it has a good feed-back to fertilization and irrigation, it has a good resitance to drought, it could be cultivated on various soil types, and could be used for many purposes [9, 10].

Maize is an important cereal in Romania, being cultivate on 47.1 % of the agricultural land cultivated with cereals. For its maize

cultivated area, Romania is placed in the top in the EU-28 and among the top producers in the EU and in the world [3, 10].
Also, maize is an agro-food product required for export, Romania's trade balance being a positive one [6].
Despite that in general, maize is a resistant crop to drought, the global climate change with its extreme phenomena mainly droughts has affect this crop even in Romania imposing irrigation and specific soil tillage to assure high production performance [7].
Romania has still a low maize yield, one of the smallest in the EU-28. This situation is justified by the fact that only 0.38 % of the farms have over 100 ha average size and maize is cultivated in about 2.5 agricultural holdings of various dimensions [2].
In this context, the paper objective was to analyze the evolution of maize production in Romania in the period 2007-2015 using the empirical data provided by the National Institute of Statistics. Another purpose was to identify the measure in which the cultivated surface and maize yield have influenced maize production, as a reflection of what type of agricultural system is maize production, an intensive or extensive one.

MATERIALS AND METHODS

The paper is based on the empirical data regarding maize cultivated area, yield and production provided by National Institute of Statistics for the period 2007-2015. The dynamics of these indicators was graphically represented and interpreted by means of trend line.
the method of the chained substitution of factors was use to analyze the influence of maize cultivated area and yield on maize production, starting from the formula:

$$P = A*Q, \quad (1)$$

where P= maize production, A = cultivated area and Q= average maize production. The production change, ΔP, will have the following formula:
$\Delta P = P_i - P_{i-1}$,
where P_i= production in the year i, i=1,2,....n, and P_{i-1}= production in the year i-1.
Replacing the symbols in the formula, we obtain:

$$\Delta P = Q_i*A_i - Q_{i-1}* A_{i-1}, \quad (2)$$

where Q_i= average production in the year i, and Q_{i-1}= average production in the year i-1; A_i= cultivated surface in the year i, and A_{i-1}= cultivated surface in the year i-1.
The influence of the two factors on maize production will be:
-The influence of the cultivated area:

$$\Delta A= A_i* Q_{i-1} - A_{i-1}* Q_{i-1} \quad (3)$$

-The influence of the average production:

$$\Delta Q = A_i* Q_i - A_i* Q_{i-1} \quad (4)$$

Finally, the production change, ΔP, is due to the changes in cultivated surface, ΔA, and the changes in maize yield, ΔQ, according to the formula:

$$\Delta P = \Delta A + \Delta Q \quad (5)$$

The results of this calculations were tabled and correspondingly interpreted.
Also, it was studied the regression of production in relation to the cultivated area and average production, as well as the determination coefficient and coefficient of correlation.

RESULTS AND DISCUSSIONS

The maize cultivated area. The cultivated surface with maize has varied in the analyzed period from 2,525 thousand ha in the year 2007 to 2,604 thousand ha in the year 2015. Therefore, in the analyzed period, maize cultivated area increased by 3.12 %.
Even thou it was noticed this general trend, it is obviously that from 2007 to 2010, the cultivated area registered a continuous decline, and then it increased in the years 2011 and 2012, being followed again by declines in 2013 and 2014, and finally in the last year of study it increased again. This variations were caused by the importance of

maize in crop structure, to assure crop rotation.(Fig.1).

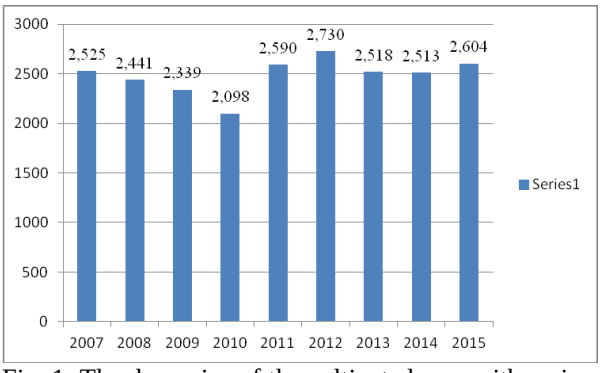

Fig. 1. The dynamics of the cultivated area with maize, Romania, 2007-2015 (Thousand ha)
Source: Own design based on the date provided by National Institute of Statistics Database, 2017.

Maize occupies the highest share in the cultivated area with cereals, 48%, taking into account the importance of the maize grains for human and animal consumption, and for industry. Also, maize has an important share in the cultivated area of Romania, being about 32 %.(Table 1).

The average maize production recorded a general ascending trend from 1,526 kg/ha, the lowest performance, recorded in the year 2007, to 3,449 kg/ha registered in the year 2015. Therefore, during this period, maize yield increased by 126.01 %.

The highest performance was 4,770 kg/ha registered in the year 2014. The fluctuation of yield from a year to another were determined by a large range of factors and mainly by the climate factors.

The years with strong droughts 2007 and 2012 were deeply marked by a diminishing maize yield, with a negative impact of maize production.(Fig.2).

Table 1.The share of maize in the cultivated area with cereals and in the total cultivated area in Romania, 2007-0215 (%)

	2007	2008	2009	2010	2011	2012	2013	2014	2015
% in the cultivated area with cereals	49	47	44	42	50	50	46	46	48
% in the cultivated area	32	31	30	27	32	34	31	31	32

Source: Own calculation based on the data provided by National Institute of Statistics Database, 2017.

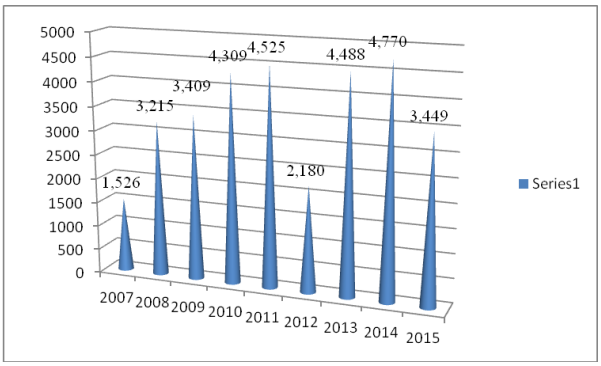

Fig. 2. The dynamics of the maize yield, Romania, 2007-2015 (kg/ha)
Source: Own design based on the data provided by National Institute of Statistics Database, 2017.

The maize production increased in the analyzed period by 133.13 % from 3,854 thousand tons in the year 2007 to 8,985 thousand tons in the year 2015. However, analyzing the figures, in the year 2007 it was recorded the lowest maize production, while in the year 2015 Romania registered the highest maize production. The variations were caused by the changes in cultivated surface and average production per surface unit. (Fig.3.).

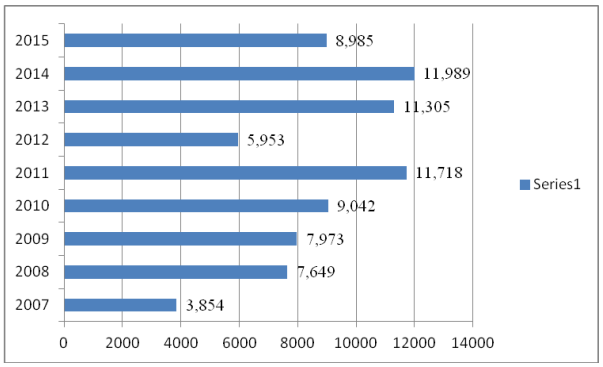

Fig. 3. The dynamics of the maize production, Romania, 2007-2015 (Thousand tons)
Source: Own design based on the data provided by National Institute of Statistics Database, 2017.

Maize production has an important place among the cereals cultivated in Romania, proved by its highest contribution to cereals production. In 2015, the share of maize in cereal production was 47 %, but it varied during the analyzed period from 47%

recorded in 2008 to 56 %, the highest share, registered in the year 2011 (Table 2).

Table 2.The share of maize production in the cereals production, Romania, 2007-2015 (%)

	2007	2008	2009	2010	2011	2012	2013	2014	2015
% in the cereals production	49	47	54	54	56	46	54	54	47

Source: Own calculation based on the data provided by National Institute of Statistics Database, 2017.

The maize production change (Δ P) in the analyzed period. The production change has varied from a year to another, having both positive and negative values. It recorded + 5,352 thousand tons change, the highest change in absolute value in the year 2013 versus 2012, and +124 thousand tons in the year 2010 versus 2009. The negative change was recorded in the year 2012 versus 2011, - 5,765 thousand tons, and - 3,004 thousand tons in the year 2015 versus 2014, these declines being determined by drought.(Table 3).

Table 3. Maize production change, Romania, 2008-2015 (thousand tons)

	2008 vs 2007	2009 vs 2008	2010 vs 2009	2011 vs 2010	2012 vs 2011	2013 vs 2012	2014 vs 2013	2015 vs 2014
Δ **P**	3,995	124	1,069	2,676	-5,765	5,352	684	-3,004

Source: Own calculation based on the data provided by National Institute of Statistics Database, 2017.

The influence of the cultivated area on maize production has been in the most of cases a negative one, ranging from -22 thousand tons in the year 2014 versus 2013 to -819 thousand tons in the year 2010 versus 2009. A positive influence +2,119 thousand tons was noticed in the year 2011 versus 2010, and 633 thousand tons in the year 2012 versus 2011, and 434 thousand tons in the year 2015 versus 2014.(Table 4)

Table 4. Maize production change due to the change of the cultivated area (thousand tons)

	2008 vs 2007	2009 vs 2008	2010 vs 2009	2011 vs 2010	2012 vs 2011	2013 vs 2012	2014 vs 2013	2015 vs 2014
Δ **A**	-128	-328	-819	+2,119	+633	-461	-22	43

Source: Own calculation based on the data provided by National Institute of Statistics Database, 2017.

The influence of the maize yield on maize production was a positive one in the most of the years, except 2012 versus 2011 and 2015 versus 2014, when the country was facing a string drought which deeply diminished production. In this years, the change of the average production accounted for -6,398 thousand tons, and respectively for -3,438 thousand tons (Table 5).

Table 5. Maize production change due to the change in maize yield (thousand tons)

	2008 vs 2007	2009 vs 2008	2010 vs 2009	2011 vs 2010	2012 vs 2011	2013 vs 2012	2014 vs 2013	2015 vs 2014
Δ **Q**	4,123	452	1,888	557	-6,398	5,813	706	-3,438

Source: Own calculation based on the data provided by National Institute of Statistics Database, 2017.

The correlation coefficients and coefficient of determination between maize production and cultivated area, (P*A), between maize production and maize average production (P*Q), and between cultivated area and average production (A*Q) are presented in Table 6.

The coefficient of correlation between cultivated area and production is a weak one, r = 0.080, reflecting that maize production is not influenced by the cultivated surface too much. Also, the coefficient of determination reflected that the change of maize production was determined in a very small proportion by the change of the cultivated surface, just 0.65 %.

The coefficient of correlation between maize yield and maize production has a high value, reflecting that the output per ha is the key factor for increasing production performance,

r = 0.968. The same aspect was confirmed by the coefficient of determination whose value was R^2= 0.9386, proving that the variation of production is determined 93.86 % by the variation of maize yield.
Finally, the coefficient of correlation between the cultivated area and maize yield has a low value, r = 0.321, and also the coefficient of determination confirmed this weak relationship by its value, reflecting that just 10.31 % of maize production change is due to the change of the cultivated area.
(Table 6).

Table 6.The coefficients of correlation (r) and coefficients of determination (R^2) between the three indicators characterizing maize production

Pair of indicators	r	R^2
Cultivated area x Production (A*P)	0.080	0.0065
Yield x Production (Q*P)	0.968	0.9386
Cultivated area x Yield (A*Q)	0.321	0.1031

Source: Own calculations.

The regression functions between the three pairs of indicators characterizing maize production are presented in Fig.4,5 and 6.

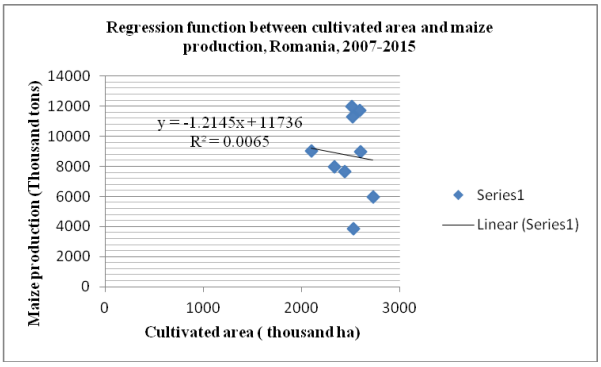

Fig.4. Regression function between cultivated area and maize production, Romania, 2007-2015
Source: Own design based on the data provided by National Institute of Statistics Database, 2017.

The regression function y = -1.2145x + 11736, between cultivated area and maize production reflects a general very weak influence (Fig.4.)
The regression function y = 2.3633x + 349.54, between maize yield and maize production reflects a string positive influence, the higher maize yield the higher maize production. (Fig.5.)

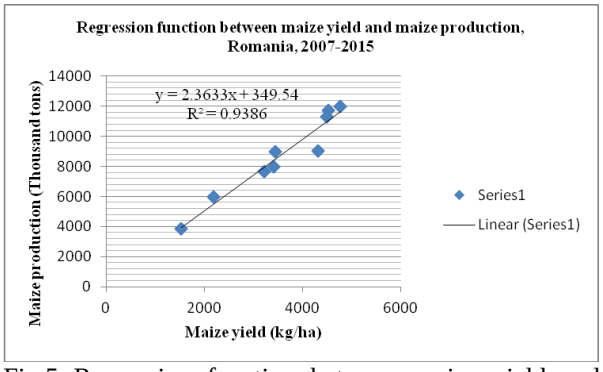

Fig.5 Regression function between maize yield and maize production, Romania, 2007-2015
Source: Own design based on the data provided by National Institute of Statistics Database, 2017.

The regression function y = -1.9855x + 8473.7, between cultivated area and maize yield reflects a weak influence (Fig.6.)

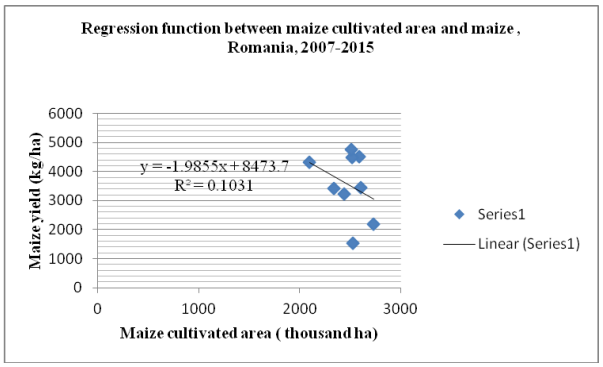

Fig.6. Regression function between cultivated area and maize yield, Romania, 2007-2015
Source: Own design based on the data provided by National Institute of Statistics Database, 2017.

CONCLUSIONS

The analysis regarding maize production in Romania in the period 2007-2015 reflected an increase of the cultivated surface by 3.12 %, maize remaining the most important crop with a share of 48 % in the cultivated area with cereals and 32 % in the cultivated area in Romania. In 2015, maize production was 2,604 thousand tons.
Romania has a high potential to produce maize, the performances of about 12,000 thousand tons in the years 2013 and 2014 proved this, placing Romania close to France among the most important producers of maize in the EU-28. Maize is an important cereal in

Romania, contributing by 47 % to cereal production.

Maize yield has substantially increased in the analyzed period by 126 %, reaching 3,449 kg/ha in 2015. However, the output per ha recorded by Romania is still very low compared to average production registered by other EU countries.

Maize production changes are mainly determined by average maize production ($r = 0.968$ and $R^2 = 0.9386$), and in a weak measure by cultivated surface ($r = 0.080$ and $R^2 = 0.0065$). Also, between the cultivated surface and maize yield is a weak positive correlation and reduced determination ($r = 0.321$, $R^2 = 0.1031$).

The same aspect relationships were confirmed by the regression functions between these indicators.

Therefore, as a final conclusion, maize yield is the key factor increasing production. This is very important for farmers who must be aware that only being focused of the tools to growth maize yield they could obtain higher maize productions. In this respect, it is important to use high value certificated maize seeds from hybrids with a higher production potential, to apply the corresponding agricultural works according to the modern technologies, to take into account the need of crop rotation, to assure the corresponding plant density per unit of surface, the adequate doses of fertilizers, to take care of pest control, to assure irrigation and also to assure the insurance of maize culture against climate phenomena, floods etc.

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