SENSITIVITY ANALYSIS FOR MAIZE CULTURE

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Abstract

Maize, one of the most traded agricultural products in the world, was chosen for analysis from several cereals and oilseeds owned by a farm in Ilfov County. Economic analyses were performed on this crop in order to determine: expenses per 1,000 lei income, gross margin and their share in the gross product, rate of net income, rate of operating expenses and rate of depreciation. Following the analysis and evaluation of the mentioned indicators, the sensitivity analysis was applied, this being also the purpose of this paper. Sensitivity analysis highlighted the gross margin in relation to changes in price and average production, based on which the main sources of risk or opportunity in terms of crop profitability can be identified.

*Key words***:** *maize, gross margin, sensitivity analysis*

INTRODUCTION

Maize (*Zea mays* ssp), one of the cereals about 10,000 years old [9], has become over time one of the staple foods in many parts of the world with a world production that has far exceeded the production of other cereals. For example, in 2018 the world production of maize exceeded by 47% the production of wheat and by 35% the production of rice [4] and this is due to its uses in other fields, other than direct consumption by humans, such as: feeding in the livestock sector, production of ethanol, starch, syrup and alcohol [6].

Thus, due to its wide uses, corn is traded on international markets, being bought and sold by investors around the world, its price being formed depending on several factors.

According to the objective theory of value, price is the monetary expression of value [3]. This theory argues that the price expresses the value of the goods brought to market. In this sense, the deciding factors in forming the price for corn sold at the farm gate in Romania are related to the mechanism of the product market, dictated by supply and demand and the cost of production with it (inputs, labor, storage, extraordinary costs / unforeseen costs, taxes, etc.) [1], the financial support (subsidy) granted to this crop, the

quantity and quality of maize as well as the added value of the producer.

Both, price fluctuations and production fluctuations influence the economic margin of the economic agent. Gross margin is the indicator that shows the trends of the final financial results (profit or loss). In other words, this indicator leads to the identification of information on the viability of products and implicitly of the farm, the planning of future business, as well as the improvement of farm management [7].

Gross margin fluctuations can be predicted depending on the sensitivity analysis, which studies how the variation of a project result (output values) can be attributed to various variations of the input parameters (input values). Sensitivity analysis can also be the starting point of risk analysis [5].

Thus, the maize crop from a small agricultural holding located in Ilfov County was chosen as a case study, in order to perform the sensitivity analysis.

The aim is to identify changes in gross margin and the need to identify key sources of variability and uncertainty for the variation of an expected outcome, so that decisions are better. In this paper, the option is for deterministic sensitivity analysis, which can be numerically implemented based on a step-

by-step formula. A common approach is to change one factor at a time (OAT) to see the effects it has on the outcome. The approach involves moving one factor at a time and returning to the centre/base point after each move. In this case, any observed change with respect to a result will no doubt be due to the change of a single factor, while all other factors remain fixed at the central (baseline) value.

MATERIALS AND METHODS

To apply the sensitivity analysis, the factorial analysis of the operating result will be used initially. This analysis has as main purpose the explanation of the influence of the two factors (operating income and expenses per 1,000 lei income) on the variation of the operating result (profit) compared to a chosen reference period (in this case, compared to a different variant of average production , or compared to other possible scenarios) [2].
The influence of operating income has the following formula:

$$\Delta RE(V) = V1*(1-Ch1/V1) - V0*(1-Ch0/V0),$$

while the influence of operating expenses per 1,000 lei of operating income has the formula:

$$\Delta RE(1-Ch/V) = V1*(1-Ch1/V1) - V1*(1-Ch0/V0).$$

In order to be able to determine the effect of different values of the input parameters (independent variables) on a certain dependent variable, under certain predefined conditions the sensitivity analysis will be used. Such an analysis studies how the variation of the result (associated in this case with the corn crop) called output, can be attributed, quantitatively or qualitatively, to various variations of the input parameters, called input. In this way it can be observed to what extent the dynamics of certain input elements (inputs) can affect the final result of the execution. In general terms, this analysis can answer the question: "What if?" and is used to investigate the feasibility of an investment project. In the present case, the

sensitivity analysis can be used as an element to ensure the profitability of the maize crop before making an investment. The choice of variables in the sensitivity analysis allows the determination of the "critical" variables of the model. These are the positive or negative variations and have the greatest impact on the dependent variable (financial result) [8]. For the result variable, the gross margin (dependent variable) will be considered representative, which will be decisively influenced by the delivery price and the average production per hectare (independent variables).

In this paper, the sensitivity analysis will be performed to identify the impact of the assumptions on the evolution of average production per hectare and the delivery price on the results measured by gross margin, applying the "what if" principle. This is intended to evaluate the impact elasticities, which aim at variations of +/- 10% related to independent variables. Following the calculations will result for each analysed variable the change of the gross margin for the maize crop.

RESULTS AND DISCUSSIONS

In order to be able to apply the sensitivity analysis, the maize crop from a farm was selected.
This culture was analysed from an economic point of view for the period 2015-2019. Indicators analysed being: expenses per 1,000 lei income obtained from main production, gross margin and their share in gross product, rate of net income, rate of operating expenses and rate of depreciation expenses.
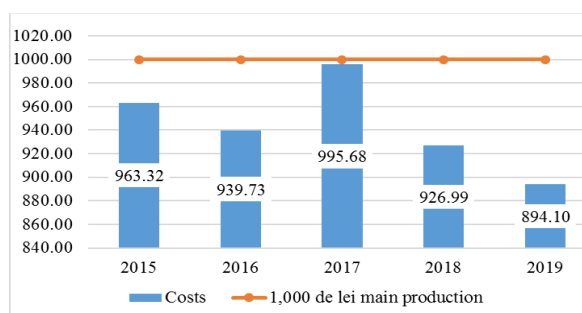

Fig. 1. Expenditures per 1,000 lei main production
Source: Own design based on data provided by the farm from Ilfov County.

From Figure 1 it can be seen that in order to produce corn worth 1,000 lei, an average of 943.96 lei is consumed.

Thus, it can be said that this crop, as shown by the rate of profitability, is economically feasible as it does not exceed the threshold of 1,000 lei spent, so the difference of 56.04 lei/ha represents the farmer's earnings.

Analysing the rates of return on expenditures compared to revenues, calculated as a ratio to intermediate consumption, it can be estimated that, on average, following a leu obtained, an operating expenditure rate of approx. 78.31%. This can be translated as follows: 78.31% of a leu obtained will go to operating costs, representing 0.78 lei (Fig. 2).
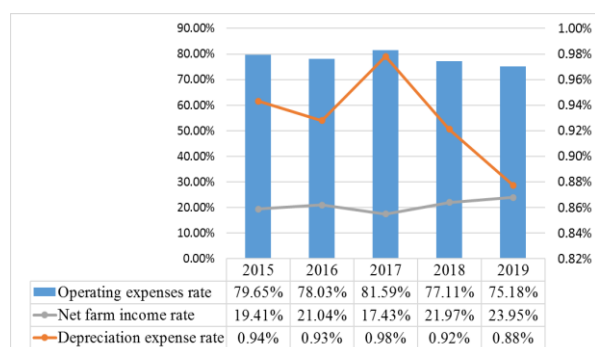

Fig. 2. Cost of revenue versus revenue for maize
Source: Own design based on data provided by the farm from Ilfov County.

This does not necessarily mean that all costs/expenses have revenue as an opposable effect. Even if this value may seem high, it should be borne in mind that other expenses are also recorded, such as depreciation, which represents, according to Figure 2, approximately 0.93%. Which means that, on average, approximately 0.09 lei out of one lei obtained will go to depreciation costs.

Following the depreciation, the net income from the holding represents approx. 20.76% of the value of one leu obtained. The evolution of this indicator for maize cultivation in the case study recorded the lowest value in 2017, of 17.43%, while in 2019 it has the highest value, of 23.95% (Fig. 3).

The main factor that intervened in this considerable increase in income for the crop in question is related to the granting of subsidies which represent on average 45% of income, but among the causes can be mentioned: the decrease in wages, given the decrease in labour, the reduction of the value of taxes, the previous investments made with the equipment park, the phytosanitary protection and the storage of the corn for a later sale with a higher price in the off-season.
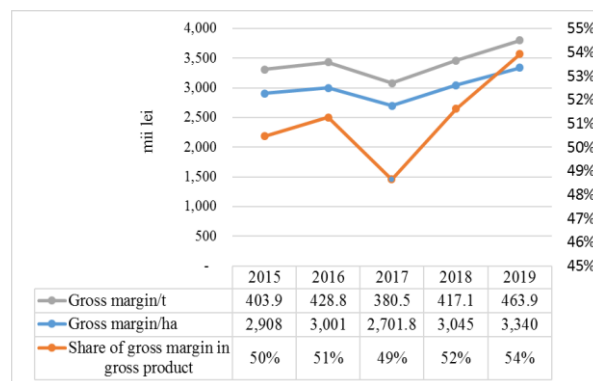

Fig. 3. Calculations of gross margin and its share in the gross product for maize (+ subsidies)
Source: Own design based on data provided by the farm from Ilfov County.

From Figure 3 it can be observed that both the gross margin per tonne and per hectare had ascending evolutions from one year to another, this being attributed to the ascending average products as well as to the prices. Of course, there were also situations when one of the indicators decreased in a certain year compared to the previous period, but the other indicator increased. Thus, it was possible to "equate" and continue the gross margin on an upward trend.

In order to perform the sensitivity analysis, a variation of +/- 10% of the price was taken into account (independent variable), noting that the gross margin (dependent variable) increases by 23%, (from 2,187 lei to 2,691 lei), noting that subsidies were not included (Table 1).

Gross margin can be considered sensitive in relation to the change in the delivery price, in other words the gross margin is sensitive to price increase, but this sensitivity may decrease depending on the level of average production and the capitalization price.

Depending on the size of the gross margin variation, the sensitivity can be considered very high or less high. In the case of maize cultivation, at an average production of 7,200

kg/ha it is observed that the gross margin is sensitive in relation to the change of the delivery price, both to its decrease and to its increase.

Table 1. Effect of average production and capitalization price on gross margin (changes of +/- 10% of independent variables)

Scenario for maize - year 2020-2021					
Average production (t/ha)	7,200				
Capitalization price (lei/t)	700		Gross		
A. Income for main production (lei)	5,040				
B. Total variable costs (lei)	2,853				
Break even (t)	4.08				
Gross margin (A-B)	2,187				
Average production 7.2 t/ha	Farm price lei/ton				
	560	630	700	770	840
5.04	-31	322	675	1,028	1,380
5.76	372	776	1,179	1,582	1,985
6.48	776	1,229	1,683	2,136	2,590
7.20	1,179	1,683	2,187	2,691	3,195
7.92	1,582	2,136	2,691	3,245	3,800
8.64	1,985	2,590	3,195	3,800	4,404
8.64	1,985	2,590	3,195	3,800	4,404

Source: own calculations based on data provided by the agricultural holding under analysis.

CONCLUSIONS

In conclusion, starting from the real situation of the maize crop, we can say that it can be profitable even from the lowest hypothetically established average production, respectively 5.04 tons/ha, provided that the capitalization price is not 0.56 lei/kg. In the unlikely event of an average maize production of this level, the recovery price may be increased only if this cereal is stored and sold in the off-season. Another situation in which the price can increase can be given by the demand and supply on the market of the respective good. Thus, in the situation where at county level, the average maize productions are around 5.04 tons/ha according to economic principles the price will rise. It should be mentioned that this increase does not have to be 10%, as it has variations that are established in the market. Such an analysis can be very useful, giving managers of agricultural holdings and not only, an overview of the profitability of a

crop in the event that one of the independent variable's changes.

The independent change of variables can be done at the will of the management team by: reducing variable costs, increasing average yields or subsequent sales at a higher price or, without their will, by: decreasing average yields due to soil conditions and increasing variable costs (irrigation) or the decrease in the market price of the analysed product.

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