MEASUREMENT OF THE COMPETITIVENESS OF AN AGRICULTURAL HOLDING FOLLOWING THE MODELING AND SIMULATION OF PRODUCTION SYSTEMS

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Abstract. *The purpose of this paper is to demonstrate that the use of the linear programming method can lead to solutions to improve economic performance that positively influence the level of competitiveness of the economic agent. Thus, in order to be able to support and demonstrate this, an agricultural unit, located in the South Muntenia region, Romania, was analysed within which the technical and economic characteristics as a whole and on crops were identified. Before analysing the competitiveness of the agricultural unit, was identified the type of market on which the farm operates. This leads to a graphical representation of the Lorentz curve showing the distribution of market income for economic operators operating under the CAEN code 0111 (Cultivation of cereals (excluding rice), leguminous plants and oilseeds). In the end, the measurement of the competitiveness of the agricultural holding before and after the application of the linear programming method led to the idea that the application of such a method can increase the competitiveness of the agricultural holding on the market, but this is not a mandatory condition. Also, this method can have the role of forecasting, by simulating possible situations ("what if?"), which can lead to the formulation of strategies for maintaining an economic agent on the market.*

Keywords*: competitiveness, economic performance, modelling and simulation,, strategies*

INTRODUCTION

The need and importance of this work is given by the growing fragmentation of agriculture, the presence on the market of many small and medium-sized farms that often cannot keep up with market growth or market leaders. For example, in 2019, within the southern region of Muntenia there were the following number of agricultural holdings: 518,701 - cereals for grains, 65,509 - industrial plants, 22,402 - legumes for grains (INSSE, 2019), noting that their number decreased on average by about 12.6% compared to the previous year (EURES, 2019). By definition competitiveness can be described as the ability to withstand competition, being linked both to the competitive environment and to the ability to achieve performance through market participation (GAVRILĂ, 2009). But as the figures show, many of the existing farms until 2018 disappeared in 2019, one of the reasons being the sudden growth of the market or the competition that managed to take them off the market.

In order to achieve the objective of the paper was taken into analysis a farm located in the southern region of Muntenia, and for analysing the competitiveness were taken into account technical and economic indicators provided by the farm.

Competitiveness factors within companies can have several bases of comparison, such as: a) financial competitiveness - which aims at the size of profit, return on equity, self-financing capacity, ability to cope with repayment; b) commercial competitiveness - which aims at: the evolution of turnover, profitability threshold, position in the life cycle for each product supplied, commercial notoriety (marketing), sales volume (can characterize the size of the economic agent); c) human competitiveness - which aims at: the level of qualification, the absenteeism rate and the employment rate, but also the labor productivity; the last basis of comparison is given by d) technical competitiveness - which takes into account the nature of the work equipment (performance and / or age), the level of automation and technical progress, supply and relationship with suppliers. (RUSSU, 1998).

From the four bases of comparison, were chosen factors that lead to the same direction of evolution of the economic phenomenon, being selected only those whose value increase will correspond to an increase of economic performance. Thus, the factors were selected: profit, turnover, market share, break-even point (value units), safety index and labour productivity. By analysing them, the degree of competitiveness of the economic actor will be outlined.

The competitiveness of the agricultural holding will be analysed for 2019, both on the real system and following the modelling and simulation of the production structures of the farm in order to determine whether the modelling and simulation of the real system can influence competitiveness.

MATERIALS AND METHODS

In order to be able to measure the competitiveness of the farm under analysis, it will be necessary to identify the type of market (in terms of symmetry) on which the farms operate. This is achievable by using the Gini coefficient, expressed by the formula (Voiculescu, 2001):

$$G = \sqrt{\frac{n\sum c_i^2 - 1}{n - 1}}$$

c = market share of economic operator "i" (had in analysis);
n = number of economic agents;

It should be noted that the Gini coefficient can take the following values: $0 \leq G \leq 1$, and depending on its value the markets are classified into [5]: very high concentration $0.8 < G \leq 1$; high concentration $0.6 < G \leq 0.8$; average concentration $0.4 < G \leq 0.6$; reduced concentration $0.2 < G \leq 0.4$; very low concentration $0.0 < G \leq 0.2$;

Ci = market share of economic operator 'i', defined as the percentage of sales revenue of an economic operator in a competitive market over a given period of time. It is calculated by the ratio made between the total sales volume of the company during a reporting period, to the total sales of the respective industry (local, county, regional, national, etc.) in the same period (CPi = Vi / V * 100 = CAi / CA * 100; where CP- market share; V-sales volume expressed in sales revenue; Vi-sales volume of company "i", CA-turnover, CAi-turnover of company "i”).

If there are up to 20 economic agents on the market, they are ordered individually in the form of a table, and for more than 20 they will be grouped in deciles. The decile grouping method (Dănciulescu, 2012) is a form of dividing a data set into subcategories of the same size. A decile will be used to classify large data sets from the highest values to the lowest or vice versa. This method will allocate decile ranks to a data set, arranging the ascending data set.

For Ilfov County, where the agricultural holdings is located, there are a number of 148 companies operating under the CAEN code 0111. Thus, in order to be able to determine the structure of the market and the positioning of the farm unit in the market, the grouping of economic agents in deciles will be done using the following formula (INVESTOPEDIA, 2021):

$$X_{Dh} = x_{Dh}^{inf} + \left(\frac{h * n}{10} - S_{Dh-1}\right) * \frac{k}{f_{Dh}}, \qquad h = \overline{1,9}$$

where: n = volume of statistical units; h = mean of 1.9 (standard); Xinfdh - represents the lower limit of the interval in which the XDh decile is placed; SDh-1 - represents the sum of the frequencies that precede the interval in which the decile is placed; k = the size of the interval corresponding to the decile XDh; fDh = frequency of the interval in which the decile XDh is placed.

For a graphical representation of the Gini coefficient, a Lorentz curve will be defined, which shows, in a graphical way, the distribution of income on economic agents operating under the CAEN code 0111. The chart will make the connection between the percentages of economic agents existing in the market and the revenues obtained by them (MERUȚĂ, 2010).

Once the degree of concentration has been established, as well as the market structure for the agricultural holdings under analysis, the competitiveness portrait of the economic actor will be outlined through the "competitiveness polygon", which is also called the "graphic method"(GAVRILĂ, 2009) (VOICULESCU, 2001). For the realization of this polygon, the following indicators will be evaluated: profit, labour productivity market share, fiscal value, break even and security index. Because the indicators taken into analysis will have different dimensions, it will be necessary to normalize (ALBULESCU, 2015) them for the purpose of a common evaluation, but also to make a radar diagram. After the normalization of the values, the polygon / competitiveness portrait will be built, with the mention that each indicator of the polygon will correspond to one of the vertices of the polygon that is measured from the centre of the polygon on the “line / radius” that unites the centre that peak (RUSSU, 1998).

To optimize production structures and resources, the data provided by the farm were used, arranged in the form of equations to find optimal solutions for modelling and simulation using linear programming. Thus, we start from an initial real solution that will later change with a much better one until we reach an optimal solution, according to the restrictions imposed on the creation of the mathematical model. This linear programming model has the role of establishing and ordering crops in order to obtain the highest yields with a maximum benefit (profit) and minimum effort (expenses). In this activity, which uses linear programming, three very important elements will be used, these being: the real system, the model, as well as the two modelling and simulation relations (online courses - Linear programming, Cantemir University, 2018).

In Excel, the linear programming problem was written in tabular form, symbolizing the fact that all constraints are equations, with the right side greater than or equal to zero, and the variable a coefficient equal to +1 in one equation and 0 in the others. , called the base variable associated with the equation (GHEORGHE, 2012). A table of equations written in tabular form has the following mathematical form behind it (CIONTU, 2015) (GHEORGHE, 2012): max (min) $C_1X_1+ C_2X_2+\dots\dots C_nX_n$ in the presence of restrictions:

$$a_{1,1} X_1 + \dots : a_{1,n} X_n \le b_1$$
$$a_{2,1} X_1 + \dots : a_{2,n} X_n \le b_2$$
$$\vdots \quad \vdots \quad \vdots$$
$$a_{m,1} X_1 + \dots : a_{m,n} X_n \le b_n$$

and must comply with the following conditions (Linear programming, Cantemir University, 2018) (a) the coefficients of the objective function shall be written above the table of equation coefficients. They represent the direct increase per unit of the objective function by increasing each variable by one unit, neglecting the effect of constraints; (b) to the left of the table, write the basic variables corresponding to each equation and its coefficient according to the objective function; (c) at the base of the table there are two lines: - the line zj which represents the decrease in the value of the objective function as a result of the increase by one unit of the variables xj, a decrease due to the effects of the constraints. It is obtained by multiplying the coefficients of each column by the objective function coefficient corresponding to the basic variable for that equation and summing them.

The indicators used in the construction of the mathematical model are: areas (number of hectares), diesel consumption (liters), consumption of phytosanitary products and fertilizers (kilograms), income and expenses. They were used in order to create the matrix, but also in order to allocate and combine the resources used in the production process, having the following purposes: full capitalization of the production capacity of the agricultural unit; obtaining a higher production per hectare (yield) with lower expenses per unit of product; increased efficiency of resources used through the use of modern, optimal technologies, the use of technical means that comply with current environmental requirements;

In order to solve the problems related to the provision of resources, as well as their use, the behaviour of the level of production must also be taken into account when changing the allocation of resources per production unit. The mathematical model for optimizing the size of the agricultural holding using the simplex (DRL, 2020) algorithm, exposed above, will include: a) the objective function (maximum / minimum); b) resources; c) model restrictions; d) the condition of non-negativity.

RESULTS AND DISCUSSIONS

In the area of Ilfov County, where the analysed agricultural holding is located, there are a number of 148 companies that have the same object of activity as its (cultivation of cereals, excluding rice, legumes and oilseeds - CAEN 0111). Thus, the economic agents carrying out activities under the CAEN code 0111 were grouped in deciles in order to determine the market structure, the farms being grouped according to turnover, sales income and gross profit.

Table 1.

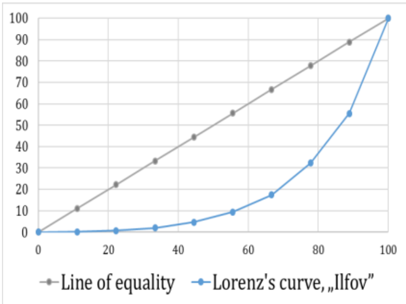
Grouping in deciles of agricultural companies operating in Ilfov County under CAEN code 0111

Year 2019	Turnover	Sales income	Gross profit
D1	53.983,5	30.229,5	18.304,8
D2	171.541	63.838,8	35.041
D3	321.564	177.201,3	51.316,8
D4	643.971	385.134	78.997
D5	974.583	669.385	150.224
D6	1.444.636	1.123.728	2.380.61,4
D7	2.397.212	2.114.326	390.781,2
D8	3.849.948	3.268.024	656.378,8
D9	70.44.915,5	6.273.584	1.307.486
GINI	0,5207	0,556	0,537

Source: own processing of existing data on the website https://www.datefirme.ro

Figure 1

Graphical representation of the Gini coefficient, Lorenz curve – sales income-



Source: own design, made on the basis of the data processed in table no.1.

Following the analysis of the Gini coefficient, it resulted that the market of products under CAEN code 0111 has a uniform spatial distribution, the Gini coefficient being below 1. If we analyse the market structure in terms of the three indicators (turnover, sales revenue, gross profit) we could say that the market has an average concentration, between $0.52 < G \leq 0.55$. In the fig. no. 1, the income distribution for Ilfov County is analysed, marked on a blue graph. It can be seen from the graph that the distribution of income for Ilfov County is uneven.

Thus, in the given situation, when the Gini coefficient varies between 0.5207 and 0.556, it can be interpreted that approximately a quarter of the analyzed companies own three quarters of the monetary units in the market. Meanwhile, the other three quarters of the company hold a quarter of the monetary units on the market.

The agricultural holding taken as a case study, registered for the period 2015-2019 the following variation of the total number of hectares, which are between 785-910 hectares.

The total areas were attributed to crops of: wheat, rapeseed, corn, and sunflower as it can be seen how in the Table 2.

Table 2

Crop structure for the 5 years under analysis(hectares)

Crop / year	2015	2016	2017	2018	2019
Wheat	350	300	310	293	310
Rapeseed	150	100	140	185	231
Corn	201	255	194	257	219
Sunflower	84	130	216	125	150
Total area	785	785	860	860	910

Table 3

Average productions (kg/ha)

Crop / year	2015	2016	2017	2018	2019
Wheat	5,500	6,400	6,700	6,900	6,600
Rapeseed	2,600	3,100	2,900	3,000	3,200
Corn	6,500	7,200	7,000	7,100	6,900
Sunflower	3,200	2,900	2,700	2,900	3,100

Source: data provided by the farm under analysis.

Total technological expenditures increased and decreased from one year to the next. Thus, the highest increase is observed in 2017 compared to the previous year, when the total technological expenses increase by 13.7%, followed by the increases of 2019 of 9.3% compared to 2018. Both, the increases and decreases of the total technological expenses, can be attributed to the influence given by the purchase prices with the inputs used by the agricultural exploitation (fuel price, price of materials and materials, expenses with depreciation of equipment and their maintenance). Another factor that influences the farm's expenses is the cultivated area, because with the increase of the cultivated area, the expenses also increase.

Table 4

Technological expenses (1,000 lei)

Expenses	2015	2016	2017	2018	2019
Wheat	786	649	774	674	778
Rapeseed	301	182	259	349	461
Corn	411	539	411	557	452
Sunflower	129	187	326	174	229
Total ***(milion)**	1.62	1.55	1.77	1.75	1.92
Evolution with base in a chain %		-4.31	13.7	-0.83	9.3

Table 5

Total expenses (1,000 lei)

Expenses with:	2015	2016	2017	2018	2019
Technological*	1.62	1.55	1.77	1.75	1.92
Salary	283	300	268	331	395
Rental	219	219	272	272	312
Headquarters	3.45	4.25	3.87	4.20	4.15
Total expenses*	2.13	2.08	2.31	2.36	2.63
Evolution with base in a chain %		-2.46	11.21	2.09	11.35

Source: data provided by the farm under analysis (* used for unit measure –millions)

The highest expenses are registered in 2019 and this is due to the increase of the exploited agricultural area, influencing the technological expenses as well as those with employees.

At the level of the agricultural company under analysis, the value of production increases progressively from one year to another with an average of about 6.5% per year.

In the analysis performed, the highest increase is recorded between 2017 and 2019, when the value of production increased by 11.65% and 6.1%, respectively. On the other hand, the smallest increase was recorded between 2017 and 2018 of only 3.55%.

The factors that influence this economic growth are the technical factors such as: the surface, which keeps an upward trend, the productions that also grow in a slow but safe rhythm, and economic factors that have in their center the price of capitalization of production. The value of total production recorded in 2016 was influenced by the low price offered by traders of agricultural products. In 2018, the value of production was influenced by the decrease of average productions corroborated with the capitalization prices which are in a slight decrease, compared to 2017, for wheat and corn.

Table 6

Gross income /production value (1,000 lei)

Expenses	2015	2016	2017	2018	2019
Wheat*	1.46	1.39	1.55	1.45	1.49
Rapeseed	684	479	681	960	*1.21
Corn	937	*1.23	958	*1.26	*1.1
Sunflower	399	539	886	544	671
Total*	3.48	3.65	4.07	4.22	4.48
Evolution with base in a chain %		4.84	11.65	3.55	6.10

Table 7

The economic panel of the farm

	Total gross income (without subsidies ;) (main production + secondary production)	Total expenditure	Gross profit	Profit rate %
2015	3,484,895	2,135,105	1,349,790	63.2
2016	3,653,530	2,082,624	1,570,906	75.4
2017	4,079,210	2,316,069	1,763,141	76.1
2018	4,224,145	2,364,588	1,859,557	78.6
2019	4,481,612	2,632,956	1,848,656	70.2

Source: data provided by the farm under analysis. (* used for unit measure –millions)

. In all the years analyzed, the agricultural holding registers profit, and its value increases from one year to another, except for the year 2019, when the profit decreases by 0.59% compared to the previous year. The decrease in profit can be attributed to total expenditures that were 11% higher in 2019 compared to 2018 and this is due to the increase in total area, from 860 to 910 hectares (5.8%) which led to additional charges.

The optimization within the agricultural holding under analysis was performed with the help of the Excel program. Thus, after establishing the mathematical model, which includes the objective function, the matrix of technical and economic coefficients, variables, constants, constraints and limits of the linear programming model, it was solved by running the other Simplex algorithm using the Solver.

Table 8

Matrix of coefficients and technical-economic restrictions

Crops	Corn	Sunflower	Wheat	Rapeseed	Sign	Boundaries/ resources
Restrictions	x1	x2	x3	x5		
Corn Max.	1	0	0	0	≤	330
Sunflower Max.	0	1	0	0	≤	135
Wheat Max.	0	0	1	0	≤	360
Rapeseed Max.	0	0	0	1	≤	150
Diesel (litrs)	95	101	86.3	104	≤	91,653
Weed control	16	98	52	153	≤	60,180 (lei)
Pest control	183	78	65	191	≤	122,970 (lei)
Fighting disease	100	132	205	170		150,120 (lei)
Chemical fertilizers (NPK))	133.2	152.1	141	180	≤	142.2 (t)
Workforce	20.5	27	23.8	25	≤	1,092 (h)
Total area	1	1	1	1	≤	910
Corn Min.	1	0	0	0	≥	300
Sunflower Min,	0	1	0	0	≥	102
Wheat Min.	0	0	1	0	≥	300
Rapeseed Min.	0	0	0	1	≥	110
Gross income per hectare	5,959.3	5,424.7	5,777.3	6,215	MAX	
Total expenses per hectarer	4,493.7	3,591.3	4,654.2	4,609	MIN	

Source: Own calculations based on data provided by the agricultural holding.

It should be remembered that in linear programming each maximization problem will correspond to a minimization problem, these "circulating" in pairs. In other words, we can say that always after solving a problem that aims to maximize the objective function, the duality relationship is created and a variant of minimizing it can be rewritten. The initial problem, the one that starts from solving the linear programming model, is known as the primary problem, from which will later derive another problem known as the dual problem. In addition to the above, the literature recalls that the primary solution is the structure of activities and consumption of each established restriction, while the dual solution will present the resources that are consumed in full.

Following the running of the simplex algorithm in order to minimize expenses / maximize income, optimal solutions resulted in the structure of the crops presented in table no. 9 and table no. 10.

Table 9

Solving and interpreting the primary and dual solution in the context of *minimizing the expenses*

Optimal solution PRIMAL	Optimal solution DUAL
Own primal variable (OPV) Cultivated areas X1 = 330 ha of corn X2 = 135 ha of sunflower X3 = 300 ha of wheat X4 = 145 ha of rapeseed	Dual equalization variables (VDE) Deficit of lei / ha culture expenditures ye1 = 0 lei deficit to spend / ha of corn ye2 = 0 lei deficits to spend / ha sunflower ye3 = 0 lei deficits to spend / ha of wheat ye4 = 0 lei deficit to be spent / ha of rape
Equalization primal variables (VDE) Differences between resources consumed and limits imposed xe1 = 0 ha corn deficit xe2 = 0 ha deficit sunflower xe3 = 60 ha wheat deficit xe4 = 5 ha rape deficit xe5 = 5,698 liters of diesel not consumed xe6 = 3,885 unspent lei -controlling weeds xe7 = 4,855 lei unspent - pest control xe8 = 13,150 lei unspent -combating diseases xe9 = 9,360 kg NPK not consumed xe 10 = 0 hours not consumed xe11 = 0 ha of uncultivated land xe12 = 30 ha of corn surplus	Own dual variable (VDP) Marginal expenses y1 = 115.5 lei increase of the others / 331 ha. of corn; y2 = 1,018.2 lei increase in expenditure / 136 ha. sun flower y3 = 0 lei increase in expenditure / 361 ha of wheat y4 = 0 lei increase in expenditure / 151 ha of rapeseed y5 = 0 lei increase in expenditure. / + 1 liter of diesel y6 = 0 lei increase in expenditure. / +1 leu costs weeds y7 = 0 lei increase in expenditure. / + 1leu costs pests y8 = 0 lei increase in expenditure. / + 1 leu

Table 10

Solving and interpreting the primary and dual solution in the context of *maximizing the income*

Optimal solution PRIMAL	Optimal solution DUAL
Own primal variable (VPP) Cultivated areas X1 = 330 ha of corn X2 = 102 ha of sunflower X3 = 328 ha of wheat X4 = 150 ha of rapeseed	Dual equalization variables (VDE) Surplus income lei / ha culture ye1 = 0 lei income surplus / ha of corn ye2 = 0 lei excess income -ha sunflower ye3 = 0 lei surplus income /ha of wheat ye4 = 0 lei excess income / ha rapeseed
Equalization primal variables (VDE) Differences between resources consumed and limits imposed xe1 = 0 ha corn deficit xe2 = 33 ha deficit sunflower xe3 = 32 ha wheat deficit xe4 = 0 ha rape deficit xe5 = 6,094 liters of diesel not consumed xe6 = 4,898 lei unspent - weeds xe7 = 4,654 lei not spent with pests xe8 = 1,916 lei not spent on fighting diseases xe9 = 952 kg NPK not consumed xe10 = 0 hours not consumed xe11 = 0 ha of uncultivated land xe12 = 30 ha corn surplus / surplus	Own dual variable (VDP) Marginal income y1 = 182 lei increase in income / 331 ha of corn y2 = 0 lei income increase / 136 th ha sunflower y3 = 0 lei income increase / 361 th ha of wheat y4 = 438.2 lei increase in income / 151 rd ha of rapeseed y5 = 0 lei increase in income / + 1 liter of diesel y6 = 0 lei income increase / + 1 lei weed expenses y7 = 0 lei increase in income / + 1 lei costs pests y8 = 0 lei increase in income / +1 lei in

xe13 = 33 ha surplus sunflower xe14 = 0 ha surplus wheat xe15 = 35 ha of rapeseed surplus	costs disease y9 = 0 lei increase in expenditure. / + 1 kg NPK y10 = 56.8 lei increase in expenditure./+1 h labor force y11 = 4,609 lei increase in expenditure. / + 1 ha land y12 = 0 lei increase in expenditure. / 301 ha corn y13 = 0 lei increase in expenditure. / 103 ha ha sun flower y14 = 45 lei increase in expenditure. / 301 ha wheat y15 = 0 expenditure increase. / 111 ha rapeseed
F minim 3,082,313 lei (648,908 euro)	

xe13 = 0 ha surplus sunflower xe14 = 28 ha surplus wheat xe15 = 40 ha of rapeseed surplus	disease expenses y9 = 0 lei income increase / + 1 kg NPK y10 = 212.3 lei income increase / + 1 hour labor force y11 = 577.3 lei income increase / + 1 ha of land y12 = 0 lei income increase / 301 th ha of corn y13 = 353 lei increase income / 103th ha sunflower y14 = 0 lei income increase / 301 ha of wheat y15 = 0 lei increase in income / 111 ha of rapeseed
F maxim= 5,347,102 lei (1,125,705 euro)	

Source: Simplex LP (Solver / Excel) algorithm results

For the optimal solutions, obtained in table no. 9, the following optimal values will be corresponding: Average income (Ai) = 5,238,257 lei (1,102,791 euros); Expenditures (E) m = 3,082,313 lei (648,908 euros); Profit (P) = 2,155,944 lei (453,883 euros); Profit Rate (RP) m = 0.70 lei profit per 1 lei spent.

Marginal costs (y1-y15) represent the extra costs if the farmer decides to increase one of the established activities, example: the establishment of another hectare of wheat (301st century) will bring an additional cost of 45 lei (y13), in time what an extra hectare added to the total area will bring an additional cost of 4,609 lei. Similar situations are found for corn and sunflower crops, the establishment of another hectare bringing extra costs of 115.5 lei and respectively 1,018.2 lei.

Using the same calculation formula, the income was maximized on the same technical and economic coordinates. Thus, for the optimal solutions, presented in table no. 10. The following values will be corresponding: Ai = 5,347,099 lei (1,125,705 euros); E = 3,212,150 lei (676,242 euros); P = 2,134,949 lei (449,463 euros); RP = 0.66 lei profit per 1 lei spent.

Marginal income (y1-y15) is extra income if the farmer decides to increase one of the established activities, for example: increasing the area of corn by one hectare will bring an additional income of 182 lei, while one hectare in addition to rapeseed will bring an income of 438.2 lei and also, the increase of the total area by one hectare will register an income of 577.3 lei. As can be seen, surplus / surplus resources do not influence income. For example, for the 28 hectares of wheat surplus (xe13), the income remains 0 as it has already been established that the optimum is 338 hectares, which means that the establishment of another hectare above the established limit will be able to bring a profit.

Analysing the data from the two tables above, 9 and 10, it is noted that an increase of one hectare of the total area will bring on the one hand an expense of 4,609 lei, and on the other hand an income of 577.3 lei, but, it should be noted that the two tables will never be calculated together. It is wrong to say that increasing the total area by one hectare will actually bring a loss of 4,051.7 lei (income, table no. 3 -expenses table no.2) because this would mean optimization on both levels at the same time (minimum-maximum) which the solver does not allow, being a multicriteria optimization. Therefore, the farmer will have to choose from the two optimizations, performed separately, on the optimal one depending on the given situation.

The modelling and simulation resulted in data not very close to the real ones, as can be seen in table no. 11, the areas used for the cultivation of the four crops did not register major oscillations compared to the real ones for the wheat and sunflower crops. While for the maize crop there is an increase of 50% of the simulated areas compared to the real ones, and for the rapeseed crop there is a decrease of approx. 60% of the simulated surfaces compared to the real ones. Also, it can be observed that depending on the variant chosen for optimization (maximum income -Max, V, or minimum expenses -Min, C) the technical indicator (surface) will have reflection / will influence the economic part as well.

Table 11

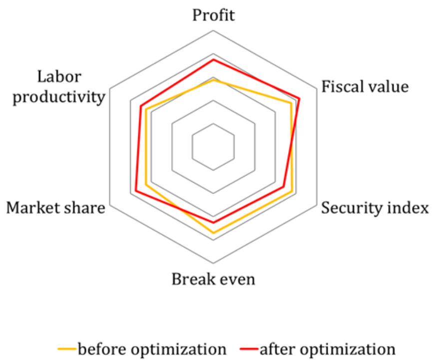
Comparative analysis regarding the real situation of the technical and economic elements vs their modelled situation

TEHNIC	real	modelling and simulation	
		min. costs	max. income
ha			
Corn	219	330	330
Sunflower	150	135	102
Wheat	310	300	328
Rapeseed	231	145	150
ECONOMIC	real	modelling and simulation	
		min. costs	max. income
euro			
Income	943,497	1,102,791	1,125,705
Expenditure	536,190	648,908	676,247
Profit	407,306	453,883	449,458

Source: Own calculations based on data provided by the agricultural holding.

Figure 2

Portrait of competitiveness following optimization



Source: design based on own calculations

Analyzing both the income and the expenses obtained from modeling and simulation, we notice that impressive revenues were obtained, as well as expenses as they led to a higher profit by about 11.4% compared to the real one in the situation of minimizing expenses and 10.4% higher when it comes to maximizing revenue. Although at first sight it could be said that the structure of the crops, provided by the program, is not an advantageous one from an economic point of view, (because the crops that consume a large amount of resources and produce a relatively low income / ha have been allocated the largest areas and vice versa) economic results prove otherwise. It should be noted that in the modeled and simulated situation no restrictions on unforeseen situations were taken into account, which in most cases may involve additional costs.

Following the optimization of the real system, it can be seen from figure no. 2 that factors such as profit, market share and turnover have increased considerably. If profit and market share are direct results of optimization, the same cannot be said about the threshold of sustainability, labor productivity and the security index. These factors being considered, rather, indirect results of the optimization that changed their value depending on the other factors.

CONCLUSIONS

The agricultural holding which was taken into analysis, has a good production and marketing capacity, represented by the market share. However, by modeling and simulating the real system it can be seen that the profit increased by about 10%, while the break-even point and the security index decreased by approx. 2.31% compared to the real ones. Reducing the threshold for sustainability and the security index reduces a possible economic risk, this does not mean that the risk is non-existent but that it is minimal.

Lowering the resilience threshold as well as the security index make the analyzed agricultural unit a less risky business. Thus, we can say that by optimizing the unit gains more points on the market compared to other businesses with the same profile which are not optimized.

By the fact that after the optimization the market share has been increased, it can be deduced that the farm has a much higher production and marketing capacity, which can give it a better result than the initial one, increasing it degree of market competitiveness.

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