MODELS OF OPTIMIZATION AND SIMULATION OF AGRICULTURAL CROP PLANS IN AGRICULTURAL HOLDINGS IN ROMANIA

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Abstract

The purpose of this paper is to promote the setting up of farms whose size will allow the practice of a viable, sustainable agriculture, capable to apply the newest technologies and lead to profit and efficiency, to the economical and organizational consolidation. The essential criterion in optimizing the crop structure is the economic efficiency, respectively the realized profit. Economic efficiency is constantly changing due to changes in raw material prices and commodity production. Hence the need to optimize the structure of crops in each cycle of agricultural production. The main indicators used in optimizing the structure of crops are: yield per hectare, production costs per unit area, profit per hectare, unit cost and rate of return. As a consequence, the resizing of the agricultural holdings, the partnership between the producers, the integration of the agricultural production, the rural development, the consumers' constant request for agricultural and food products, the decrease of the deficit of the commercial balance for the agricultural products, the increase of the population's life standard, the safety of the food, all these are goals that have to be under the continuous attention of the authorities at central and local level. The elaboration of mathematical models was oriented on the design of several structural alternatives and the elaboration of a large number of variants, because analysing the problem of establishing an optimal structure through the prism of several variants creates the possibility of highlighting the development and manifestation of different phenomena, some conclusions, not by subjective assessments or by antithesis, but on the basis of several concrete structures that each variant covers.

Keywords: Models of planning, economic, production, simulation, decision

Through demonstration, Howitt (1995) and Paris and Howitt (1998) showed that if in the framework of a behavioral simulation model are determined, based on the k-m independent activities of the model, a corresponding number of nonlinear terms of the objective function, then the model will faithfully represent the mode of functioning of the respective agricultural exploitation. These parameters are called "calibration parameters" and can be determined by using a program of linear programming based on the information collected during a base year from the analyzed agricultural system.

With a view to construct a model extreme flexible and sensitive to the environmental changes is necessary to determine a series of nonlinear parameters of the offer in the framework of the objective function (maximization of profit). In consequence the positive mathematical programming method determines these parameters based on the agricultural technological knowledge, on micro economic theory of production and a set of information available for the modeller.

A very probable source of nonlinearity of the objective function is given by the heterogeneity of the soil quality. Thus, inside the same analyzed region and even inside the same farm, the fertility and the soil quality varies very much. In this way is very probable to obtain at small distances different productions in the same branch of production. The heterogeneity of the soil confers to the marginal production a descending trend as the surface cultivated with a specific crop grows on a specific area, due to probability of incidence of some low quality land surfaces. These phenomenons were observed for the first time by Ricardo. In the present they are well known to the farmers, agronomists and researchers of the soil quality but usually they are not taken into account in the quantitative models of production.

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MATERIAL AND METHOD

The methods consist in use mathematical and economical model. The model constructed is a recursive monoperiodic positive model. With it help, the optimization of the structure of production, the farm crop rotation, the level of investments, loans and the level of investments was made within six years.

RESULTS AND DISCUSSIONS

For Romania, the agriculture is an absolute priority. As much the commercial grows as a share in the total of the agricultural production, as much as the agriculture as a whole will be more efficient, and the agricultural Romania will be more integrated in the domestic and international economic circuit.

At European level these practices have seen a use and a development of concepts when preparing the CAP reform. In the context of the assessing the impact of the proposed modifications proposed to the agricultural policy on the agricultural production can be observed using of three types of mathematical methods. (Yates, C.M. 2007).

The first legal regulation on cross The models of linear programming applied in agriculture provide answers to a set of essential questions for the agricultural decider:

- How to produce?
- What to produce?
- How much to produce?

The construction of a linear programming model (LPM) implies the achievement of a strong connection between the objectives and the constraints which take in account the activity of agricultural decider. The constructed system constraints represent a simplified image of the environment in which the farmer substantiates his decisions.(Hazell, P.B.R, and Norton, R.D. 1986).

Suppose the researcher want to analyse how a farmer will react to the manner of the distribution of the investment loans inside a branch of production investment. The resulted production in the respective branch of agricultural production "*i"*, using a ground surface x_i and two other agricultural inputs, can be represented with the help of PMP method in this way:

$$y_t = (\beta_t - \delta_t x_t)\min(x_t, a_{t2}x_t, a_{t3}x_t) \quad (1)$$

- where β_t and δ_t represent the free term, respectively the slope of the function of the marginal production for the crop "*i"*

Starting with these simplifications of the production process the optimization issue becomes:

Formula (1)

$$\max \sum_l P_l(\beta_l - \delta_l x_l)x_l - \sum_{l=1}^{3} \varpi_l a_{lj} x_i \quad (2)$$

subject of the next set of constraint s*i* :

$Ax \le b$ *respectiv* $x \ge 0$

Where:

- P_l - represents the price of one unit of production obtained by practicing the crop "*i";*
- *A* - Represents a matrix of a dimension m x n, with a_{ij} elements, representing the consumption of the input *"j"*, necessary to produce one unit of the crop "*i".* This category of coefficients represents the necessity of fertilizers to yield wheat on a surface of a hectare;
- X_l - represents the surface of land allocated to the crop "*i";*
- ω_l - represents the cost of one unit of the input *"j".* (Hazell, P.B.R, and Norton, R.D. 1986).

Be the next simplified situation identified in an agricultural exploitation in one year, considered as base:

Table 1

Situation identified in an agricultural exploitation in one year

Name of element	Unit	Wheat	Oat
Price of production	Euro/t	2.98	2.20
Average price	Euro/ha	129.62	109.98
Average production	Tons/ha	69	65.9
Gross margin calculated	Euro/ha	76	35
Surface allocated in the base year	Ha	3	2

Through the optimization of the respective model is obtained the manner of allocation of the land surface in the base year. In this way is respected the whole causal complex which acts on agricultural decider, including the way he reacts to the environmental changes.

At the level of this agricultural exploitation it is desired to construct a behavioural simulation model, which can predict for example the

agricultural decider's behaviour in the conditions of changing policy of the agricultural loan.

The graph from *figure 1* represents the cropping plan of the agricultural exploitation where the available land surface is limited (the land surface in the base year is limited to 5 hectares) and respecting the upper calibration limits (the value of production of the two crops).

We must notice that in the case of the optimal allocation of the land, the calibration constraints will be limiting for the wheat due to the fact that in average this crop registers the biggest gross margin for the cultivated unit surface. Through the calibration of the wheat cultivated surface to the observed value of the base year is taken into account the farmers' aversion against the risk (the activities with a high gross margin are characterized by a higher risk). The available land surface will restrict the surface cultivated with oat.

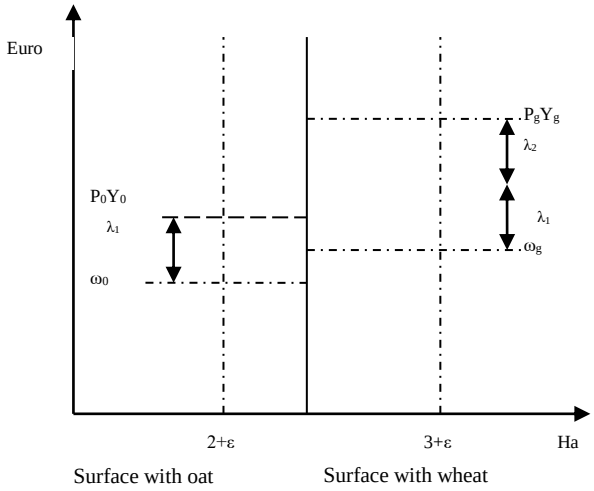

Figure 1 **Cropping plan of the agricultural exploitation**

The agricultural exploitation used in the above numerical example has an available land surface of 5 hectares. As a result of the accomplished observations it was found that in a certain year there were cultivated two crops: wheat and corn, on the surface of 2 and respective 3 hectares. The problem which is graphically represented in the *figure 1* can be written from a mathematical point of view:

$$Max(2{,}98 * 69 - 130)X_g + (2{,}2 * 65{,}9 - 110)X_o$$

The subject of the following set of constraints:

$$(i)\ x_g + x_o \le 5{,}00$$

$$(ii)\ x_g \le 3{,}01$$

$$(iii)\ x_o \le 2{,}01$$

The average production of the wheat is 76 Euro/ hectare for wheat and 35 Euro/hectare for oat. The optimal solution for the linear programming issue from above is reached when the calibration constraints limit the wheat cultivated surface to 3.01 hectare and the constraint (i) is limitative when the oat cultivated surface is equal with 1.99 hectare. The dual value of the land is 35 Euro and for those two calibration constraints is 41 and 0 Euro. Using equation 2.8 the slope of the income function can be calculated in this way:

Formula, the value used in the calculation of the free term is given by the equation 3:

$$\delta_g = \frac{41}{2{,}98 * 3{,}01} = 0{,}04586$$

Based on these parameters determined by using a LP program in the second stage the problem of linear programming becomes:

$$\beta_g = 69 + 0{,}04586 * 300{,}01 = 82{,}76$$

$$\max[2{,}98(82{,}76 - 0{,}04586 * x_g) - 130]x_g + (2{,}20 * 65.90 - 110)x_o$$

$$\text{Subject of the next set of constraints:}$$

$$x_g + x_o \le 5$$

Marginal production/ cultivated hectare with wheat is:

$$y/300 = 82,76 - 2*0,04586*300 = 55,25$$

$$VMP_g = 2,98*55,25 - 130 = 34,65$$

The value of marginal production for wheat when 3 hectares are cultivated is 34.65 Euro. This value is lower than the value of the marginal production for oat which is 35 Euro.

For comparison data from the NE Region of Romania and national level there is a higher proportion of arable land and vineyards in the NE Region towards Romania and pastures, hay fields and orchards are smaller in size to the NE Region of Romania. *(table 2*.)

Table 2

Structure of categories of use, on county areas from the NE Region of Romania – ha

No.	County	Agricultural	Arable	Orchards	Vines	Grassland	Pastures
1	Vaslui	140263	96892	1174	7372	30427	4996
2	Bacău	27459	19523	758	243	6130	805
3	Iaşi	90943	59306	2812	4681	19461	5383
4	Neamţ	29382	20837	480	490	6570	1005
	Total	288047	196558	5224	12786	62588	12189

The structure analysis by use of the first place is situated in Bacau County areas of NE Region of Romania towns with 71.10%, followed by Neamt shows some differences. Thus, if arable land, County (70.92%) and Vaslui 69.09%.

Table 3

Structure of categories of use, on county areas from the NE Region of Romania –%

No.	County	Agricultural	Arable	Orchards	Vines	Grassland	Pastures
1	Vaslui	100	69.08	0.84	5.26	21.69	3.56
2	Bacău	100	71.10	2.76	0.88	22.32	2.93
3	Iaşi	100	65.21	3.09	5.15	21.40	5.92
4	Neamţ	100	70.92	1.63	1.67	22.36	3.42
	Total	100	68.24	1.81	4.44	21.73	4.23

Structure analysis by use, the county orchards, Iasi and Bacau counties have areas of NE Region of Romania shows higher percentages and for vineyards, Vaslui some differences. Pastures have similar rates in all first place is situated in Bacau County towns counties, in contrast to the meadow, Iasi with 71.10%, followed by Neamț County is first. (70.92%) and for Vaslui, 69.09% *(table 3*). (Ungureanu, G., 2008). Total production and average production of agricultural units of NE Region of Romania are relatively modest, but are close to the national average obtained from cultures analysed. *(table 4*).

Structure of cultures of NE Region of Romania reveals a majority share for maize crop (accounting for 52.2%) followed at a considerable distance by the wheat crop (accounting for 11.9%).

Table 4

Total production at main cultures - t

No. crt.	County	Wheat and rye	Maize grains	Potatoes	Sunflower	Sugar beet	Vegetables
1	Vaslui	45207	138886	9780	16685	10185	14834
2	Bacău	11462	30295	13636	1747	2630	7917
3	Iaşi	24208	81853	27134	5013	8337	41725
4	Neamţ	11613	28219	11918	1577	7924	10130
	Total	92490	279253	62468	25022	29076	74606

Based on information gathered we proceeded to the design of the second component of the plant i.e. crop structure. Provisions O.U.G. no. 108/2001 states that commercial farms should hold property with or without lease area at least 110 meters. To respond to such tasks farmer should have high power tractor - 280 - 320 hp and agricultural machines with large working width corresponding to power tractors. In essence, Romanian farmers will be given high-yield agricultural machinery, appropriate technologies applied in countries with developed agriculture.

Given the above considerations we proposed modelling agricultural production and 80 farms 110 hectares in the hill area. These distinctions we have made light of reports indicated the Ordinance 108/2001 and the information collected from the literature on farm size in different areas of agricultural production.

In essence, the proposed dairy herds appear to be low, but in subsequent periods they will be

able to increase the speed with which farmers can ensure the investment with modern farming techniques. In relation to farm size, which differ in relation to the production area is located, we planned a number of 15-30 conventional animal heads (the number of animal species conventional cattle is the number of animal's jelly, that cow's milk), and high plain zone, 5-20 planned a number of conventional animals, depending on the size of those farms.

In the module 80 ha (*table 5*) cereals are designed to occupy 65.7%, technical plants 15.86% and 18.44% of fodder plants. In this way in the area of favourability 1 of total profit of 46,598 lei result and 582 lei / ha. In area 2 of favourability resulted in a slightly lower profit for 41,464 lei and 518 lei / ha.

Table 5

Designing crop structure - Module 80 ha

No.	Culture	Arable area	weight	Area ha	Profit F1 lei/ha	Profit total F1 lei	Profit F2 lei/ha	Profit total F2 lei
1	Wheat consumption	80	24,5	19,60	634	12.426	580,2	11.372
2	Two-row barley beer	80	13,2	10,56	535	5.650	461,5	4.873
3	Maize grains	80	28,0	22,40	724,5	16.229	653,6	14.641
4	Sunflower	80	12,5	10,00	804,6	8.046	652,9	6.529
5	Soy	80	3,36	2,69	583,5	1.570	510,1	1.372
6	Fodder plants	80	18,44	14,75	181,5	2.677	181,5	2.677
7	TOTAL	80	100	80,00	-	46.598	-	41.464

For the module with the maximum size set by Gov. 108/2001, of 110 ha were developed conventional strength of 30 animals, i.e. dairy, which require a forage base area of 17.70 hectares and 16.09% of total arable land. The remaining area was divided grain crops - 76.67 meters, which means 69.7% of technical plants - 15.63 hectares and 14.21%. In this way the total profit 1 of favourability was 65,093 lei, representing 592 lei / ha and the area of favourability 2 total profit was 58,024 lei representing 527 lei / ha (*table 7*).

It should be noted that with increasing the total area of the module increased the share of grain crops. This was not accidental, but was caused by a relatively simple logic. Forage crops are strictly determined by livestock queen planned, so appears as a restriction of minimum technical plants in general are characterized by an attractive economy, but requires a strictly individual machine systems, such as sugar beet, why which we have not got it in crop structure, although it finds very favourable conditions found across the plain of NE Region.

Table 7

Designing crop structure - Module 110 ha

No.	Culture	Arable area	weight	Area ha	Profit F1 lei/ha	Profit total F1 lei	Profit F2 lei/ha	Profit total F2 lei
1	Wheat consumption	110	26.20	28.82	634	18,272	580.2	16,721
2	Two-row barley beer	110	14.50	15.95	535	8,533	461.5	7,361
3	Maize grains	110	29.00	31.90	724.5	23,111	653.6	20,849
4	Sunflower	110	11.70	12.87	804.6	10,355	652.9	8,403
5	Soy	110	2.51	2.76	583.5	1,610	510.1	1,408
6	Fodder plants	110	16.09	17.70	181.5	3,212	181.5	3,282
7	TOTAL	110	100	110.00	-	65,093	-	58,024

On the other hand, cereals are major crops in the technological opportunities, precisely because of their relative simplicity. In addition, the finished products with the characteristics of cereal crops have high capacity storage without altering their quality indices. Therefore, Romanian farmers prefer cereal crops at the expense of other crops that require more complex technology and fewer opportunities for recovery and collection mainly technical value of products sold. It is well known tendency of the sugar refineries and oil to pay late value of those offered by farmers, which is why they turned their attention to other criteria profitable, technological facilities, with increased storage options for more particularly long and greater opportunities for recovery of costs incurred by the collection amount in question offered industries processors

CONCLUSIONS

A healthy agriculture under the structural aspect, mainly involves increasing the share of commercial farms owned by farmers of NE Region of Romania. They represent the future of agriculture in the area studied; they have directed attention to the makers of the North-eastern agriculture.

It is necessary to resort regularly to optimize the size of farms in the area taken in the study, because the current size is not an agricultural practice performance. This should take account of the zone of agricultural production, because each county for the NE Region is characterized by the climate, soil, their economic and social conditions that promote agricultural production as a whole or certain branches of crop production (vegetables, flowers, trees, vines) to a greater or lesser extent. At the level of this agricultural exploitation it is desired to construct a behavioural simulation model, which can predict for example the agricultural decider's behaviour in the conditions of changing policy of the agricultural loan.

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