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OPTIMIZATION OF PRODUCTION STRUCTURES IN ORDER TO INCREASE COMPETITIVENESS OF AGRICULTURAL HOLDINGS

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Abstract

The approach of optimizing the production structure should answer questions like: What to grow? How much of each crop? What expenses and the profit will be achieved? Taking into account these questions and that there are more possibilities of combining crops, substantiation the decisions on the new crop structure involves the use of different methods, such as: method of variants or method of linear programming.

Is chosen in the end the variant considered to be the best. The option will be according to profit, the way resources are used, the extent in which is responded to different requirements that manifests to the new production structure.

In this paper we decided to apply linear programming, as a method of optimizing the production structure.

Key words*: production structure, optimal growth, competitiveness*

Introduction

When initiating the decision-making regarding the choice of production structure, are taken into account a number of factors of influence the structure, such as: the environment that holding is connected in, the demand for crops possible to be introduced into the structure, market competition for specific products of the agricultural holding domain, inputs prices, used in the application of technologies in crop structure, the necessary land potential to obtain a high yield per hectare from different crops of production structure, the degree of capitalization of the agricultural holding, the necessary capital

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to purchase of inputs to be applied to crops from the production structure, specialized and managerial knowledge of those managing the agricultural holding, qualified workforce employed in the execution, crop rotation, if farms have large areas of land.

Materials and methods

Linear programming is used in all areas, including agricultural works[4],[5]. Crop structure optimization using linear programming is widely applied in economic research.

At the origin of linear programming are works of Leonid Kantorovich[6], Russian mathematician who founded the linear programming in 1939, George B. Dantzig[7], who published the simplex method in 1947 and John von Neumann[8], who discovered and applied the theory of duality.

The linear programming is a mathematical method for determining how to get the best results (maximum profit or minimum cost) in a mathematical model with a series of requirements represented as linear relations. Formally, linear programming is the technique of optimization objective function. Objective function of the model is the profit maximization and variables will represent different crops possible to practice in the conditions of the analyzed holding.

The relevance of the results consists in the possibility of using the methodology by the agricultural holdings managers in their approach to maximize farm profit by changing the crop structure.

Results and discussions

The agricultural unit on which data were collected is organized as an agricultural commercial society in Conțești, Teleorman county. Production profile of the unit is mixed in raising cattle and cultivation of field crops, legume.

Cultivated area is 704 ha and the crop structure is diversified: corn, barley, triticale, rapeseed, alfalfa, mash and rye (Table 1).

4 Voicu R., Turek Rahoveanu A., Ion Raluca Andreea, *The structure of production in Romanian agriculture - the gap between the EU 27*, Economics of Agriculture, Special Issue -2, I Book, 2010, p. 366-374.

5 Voicu, R., Iuliana Dobre, Mariana Bran, *The management and economic performance of the production system from the agricultural exploitations*, Metalurgia International, nr. 2/2008

6 Kantorovich, L. V., *"My journey in science (supposed report to the Moscow Mathematical Society)" [expanding* Russian Math. Surveys *42 (1987), no. 2, pp. 233-270]*, p. 8-45

7 Dantzig, G., *Linear programming and extensions*. Princeton University Press and the RAND Corporation, 1963.

8 von Neumann, J., *A numerical method to determine optimum strategy*, Naval Res. Logistics Quarterly, vol. 1, no. 2, June, 1954, p. 109-115.

Table 1. Area cultivated, income and expenditures per hectare (existing variant = variant 0)

Specification	Area cultivated (ha)	Expenditures (lei/ha)	Total expenditures (lei)	Profit (lei/ha)	Total profit (lei)
Corn	65	1703	110695	152	9880
Barley	324	1306	423144	48	15552
Triticale	10	1930	19300	30	300
Rapeseed	62	1884	116808	514	31868
Alfalfa	127	1495	189865	819	104013
Mash	76	2566	195016	237	18012
Rye	40	2812	112480	312	12480
TOTAL	704	-	1167308	-	192105

Based on data for cultivated areas, average yields, profit and expenditures per unit, provided by the agricultural unit, are calculated the profit and expenditures per hectare. The most profitable crops are oilseeds and technical plants. High costs per hectare are recorded for mash, rye, triticale, rape and corn.

Econometric model maximizes the profit function and is expressed by the following relation:

$$\text{max. } f(x) = \sum p_j x_j \text{ , } j=1, 2, \ldots, n$$

Model restrictions are:

$$\sum_{j=1}^{n} a_{ij} x_j \leq b_i \text{ ,}$$

$$x_j \geq 0 \text{ , in which:}$$

x_j – j crop surface
p_j – profit per unit of production for crop j
a_{ij} – expenditures per unit of production for crop j;
bi – available budget;
j – crop.

Existing production structure brings the followings profit to farmer:

$$P_0 = \sum_{j=1}^{7} p_j \cdot x_j = 192105 \text{ lei, in which:}$$

$P =$ total profit
$p_j =$ profit per unit of production for crop j
$x_j =$ j crop surface

Total expenditures are:

$$Ch_0 = \sum_{j=1}^{7} c_j \cdot x_j = 1167308 \text{ lei.}$$

Following the application of linear programming method is optimized the farmer structure of crops. The model is:

$$\max(f(x)) = 152x_1 + 48x_2 + 30x_3 + 514x_4 + 819x_5 + 237x_6 + 312x_7$$

Restrictions:

1.
$1703x_1 + 1306x_2 + 1930x_3 + 1884x_4 + 1495x_5 + 2566x_6 + 2812x_7 \leq$
1979648 lei

2. $x_1 + x_2 + x_3 + x_4 + x_5 + x_6 + x_7 \leq 704$

3. $x_j \geq 0, \; j = \overline{1,7}$

Variant 1:

In a first variant, not impose restrictions on the maximum limits of the surface, therefore, the result of the program is the allocation of 704 ha total area to crop that has the highest profit per hectare - alfalfa.

Total profit and expenditure for the first variant are:

$$P_1 = 576576 \text{ lei,}$$
$$Ch_1 = 1052480 \text{ lei.}$$

Variant 2:

To ensure crop rotation should be formulated restrictions regarding the maximum limits of crops. Lower limits are necessary for cereals: area cultivated with corn to be at least 300 ha and the barley area at least 300 ha. The maximum limit that can grow alfalfa is 200 ha:

$$x_1 \geq 300$$
$$x_2 \geq 300$$
$$x_5 \leq 200$$

Consequently is obtained the following structure of production:

Corn: $x_1 = 300$ ha

Barley: $x_2 = 300$ ha

Triticale: $x_3 = 0$ ha

Rapeseed: $x_4 = 0$ ha

Alfalfa: $x_5 = 104$ ha

Mash: $x_6 = 0$ ha

Rye: $x_7 = 0$ ha

As a result are obtained the following values for the variables and for the profit (P) and total expenditures (Ch):

$$P_2 = \sum_{j=1}^{7} p_j \cdot x_j = 145176 \text{ lei}$$

$$Ch_2 = \sum_{j=1}^{7} c_j \cdot x_j = 1058180 \text{ lei}$$

Variant 3:

In variant 2, triticale, rapeseed, mash and rye are missing from rotation, which does not allow obtaining of certain feed and no rational rotation of crops, therefore, are introduced new restrictions on the minimum limits of them:

$x_3 \geq 10$

$x_4 \geq 50$

$x_6 \geq 50$

$x_7 \geq 50$

Consequently is obtained the following structure of production:

Corn: $x_1 = 100$ ha

Barley: $x_2 = 300$ ha

Triticale: $x_3 = 20$ ha

Rapeseed: $x_4 = 50$ ha

Alfalfa: $x_5 = 134$ ha

Mash: $x_6 = 50$ ha

Rye: $x_7 = 50$ ha

As a result are obtained the following values for the variables and for the profit (P) and total expenditures (Ch):

$$P_3 = \sum_{j=1}^{7} p_j \cdot x_j = 193096 \text{ lei}$$

$$Ch_3 = \sum_{j=1}^{7} c_j \cdot x_j = 1164130 \text{ lei}$$

In the table below are summarized the results of linear programming method in the three variants above.

Table 2 Centralization of the results of optimizing the production structure

Specification	MU	Variant 0 (existing)	Variant 1	Variant 2	Variant 3
Corn	ha	65	0	300	**100**
Barley	ha	324	0	300	**300**
Triticale	ha	10	0	0	**20**
Rapeseed	ha	62	0	0	**50**
Alfalfa	ha	127	704	104	**134**
Mash	ha	76	0	0	**50**
Rye	ha	40	0	0	**50**
Total expenditures	lei	1167308	1052480	1058180	**1164130**
Total profit	lei	192105	576576	145176	**193096**
Profit rate	%	16,4	54,7	13,7	**16,5**

Conclusions

– the farm economic activity is more profitable following optimization the structure of production, profit increasing to 100.5% and total expenditures reducing to 99.7%.
– optimal for the structure of production is variant 3, because both the total profit and profit rate increase from the original variant. In addition, maintaining of all crops in the structure contribute to their rational rotation.
– although variant 1 brings the highest level of profit and profit rate, it can not be considered because in the production structure is found only one crop: alfalfa.

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