OPTIMISING PRODUCTION STRUCTURE OF AGRICULTURAL HOLDINGS AS A RESULT OF THEIR ADAPTATION TO MARKET REQUIREMENTS

George UNGUREANU[1], Eduard BOGHIŢĂ[1], Dan BODESCU[1], Dan DONOSĂ[1], Cătălin Răzvan VÎNTU[1]

e-mail: ungurgeo@uaiasi.ro

Abstract

The purpose of the paper is the analysis of the economic and financial results, as well as the optimum sizing at the level of various types of agricultural holdings in the NE region, in the Romanian contemporary agriculture. As a consequence, the resizing of the agricultural holdings, the partnership between the producers, the integration of agricultural production, the rural development, the consumers' constant request for agricultural and food products, the decrease of the deficit of commercial balance for 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. A market economy with improved efficiency implies perfecting production methods. To perfect the planning means to correlate the necessities and possibilities of agricultural production enterprises with the company's needs. If within the centralized economy many problems are solved through directives, provisions, laws and so on, in the case of market economy the maximum percentage of one specific culture within a certain ploughable surface cannot be imposed to the producers, due to a simple fact: it solely concerns the company's interests. By means of indirect ground tax for each culture, one can impose the quantum of the rational surface.

The present paper aims at contributing to a change in the structure of agricultural crops by enhancing the economic efficiency of agricultural production in the agricultural exploitations in the North-Eastern part of Romania, through their evolution from an extremely low level of efficiency to the status of competitive enterprises, progress which can be attained by combining traditional elements with partially modernized technlogies and engaging them in the market economy.

Key words: economic model, optimization, agricultural holdings, production, simulation, decision

The paper has the purpose to approach a fundamental problem of the Romanian agriculture, that is the one of the intensive development as a result of a new phase of the vertical cooperation process, as well as to elaborate economical-mathematical models as being this a necessity of a optimum dimension of the agricultural holdings, rationalization of the production processes, of the specific consumes, of the economy of the labor force and the adaptation of the request of the ago-alimentary products to the requirements of the market. Under these circumstances, the paper tries to demonstrate the importance of the optimum dimension of the agricultural holdings and the rationalization of the relationships between them along the economic chain, as a result of the coordination or orientation of the decisions regarding the production attained and its capitalization. In the context of the nowadays economic situation in the Nod-East region of Romania, the agricultural holdings need a change of attitude and strategy, in order to obtain a production at European standards, according to the requirement of the market.

By the agro-alimentary integration of the NE region of Romania we want the concentration of the agricultural production in this region and this will lead to the specialization of the agricultural holdings on an each time narrower range of products. At the same time, the specialization of the agricultural production lead inevitably to the concentration of the means of production characteristic to the direction of the specialization in the studied area, in correlation with the obtained production.

An important feature of the agriculture practiced in the NE part of Romania resides in its dual nature. On the one hand there is the existence of the individual private sector, holding approx. 82% of the overall agricultural field, plus a similar

[1] „Ion Ionescu de la Brad” University of Agricultural Sciences and Veterinary Medicine, Iași

quota of the number of farm animals; the private sector produces most of what is used in family-consumption, but also produces a high percentage of the total agricultural production destined for the market. Average-sized individual private exploitations (3.47 ha) in the NE part of Romania consumes approx. 50% of its own production, and it can reach up to 80% in the case of households/ family farms owning minimal surfaces of land.

The purpose is to promote the setting up of farms whose size 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.

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 studies underlined that in the NE Region there were some possibilities to increase the agricultural production, without other investments, whose reasonable use will lead to a more complete use of the natural conditions, of all the economic and social means, as well as to the increase of the economic efficiency of the agricultural holdings.

Therefore the integration is made by the system of the market mechanisms, which determine the economic sizing of the agricultural holdings and the rationalization of the relations between them along the economic chain, as a consequence of the coordination or orientation of the management decisions.

The results of the research will draw the attention upon the importance of the optimum sizing of the agricultural holdings according to its specialization, as well as the need of the reasonable identification of the production die in the NE Region. Eventually, a standard model of the holding groups will be made, according to the optimum size, which will allow the promotion and the practice of a technological flow according to the specialization of the holding, as well as the requirements on the market of the products. The results can be extended also for other regions having in view the size of the holdings and the characteristics of the area regarding the market request as well as the zoning of the production.The other facet of the agricultural economy in the NE part of Romania resides in its commercial nature. The agriculture in this area has a high potential, being able to provide the necessary quantities of basic food for the county's internal consumption, the food imports being thus only a source of completing and diversifying consumption.

MATERIALS AND METHOD

Hereinafter we will present such a model developed in the case of an optimum combination of vegetal and animal productions. Towards the progresses recorded by the method of economic calculation, the optimal variant of specialization and rational combination of the branches can be determined more accurately, for example, using mathematical programming methods. An example of calculation will clear us on the results that can be obtained in this way.

Taking into account the fact that due to the weather conditions and the relief, the hilly and mountainous areas have often problems regarding the agricultural exploitation of the land, and the integration of the agricultural holdings as well as the optimization of their size and the correlation with their specialization, the agriculture represents, along with the zoo technics, an important step for the economic development. The increasing of economic efficiency in agriculture requires for the optimum sizing of agricultural holdings as well as for the rationalization of production processes and the specific consumes, of the economy of labor force and the capitalization of production in optimal conditions.

RESULTS AND DISCUSION

The problem of the rational size of the agricultural holding has been for a long time a subject to think about for the agricultural specialists and general economists. In the years 1968-1970 the discussion was on top, when the so called "European structural plans" were presented, belonging to Schiller, Höcherl and Mansholt, and when the Council of the "wise" for the examination of the macroeconomic evolution was so critic regarding the agricultural structure.

At the same time, it could be interesting to have a look upon the size structure of the holdings in the U.S.A., and for this purpose a lot of research was made by dividing the land in 144 areas, then in 432 sub-regions, using the economic and mathematical methods for the optimizing of the holding and production.

Models of the optimization of production factors were elaborated in Romania, for the NE region of the country.

In Russia, the research and the practical works for the settlement and the specialization of the production were elaborated in the Institutes of

Agricultural Cybernetics. The main problems that were solved consisted in the society's need for certain products.

In Romania, after the year 1989 a lot of information about the integration, size and economic efficiency of the agricultural holding by optimizing the production factors appeared in the scientific works of several researchers such as N. Vasilescu, P. Magazin, P. Otiman, I. Fruja, C. Secrieru, D.C.Popovici and many others.

Therefore the studies made at national as well as at international level have taken into account the aspect of the size optimization of agricultural holding but without taking into consideration the agro-alimentary integration that can be the effect of the adaptation of the offer of agro-alimentary products to the market's demand.

Research was also done upon the factual conditions of increase of economic efficiency of agricultural holdings in the NE region of Romania, taking into account the human effort, the material and financial investment within the field of agricultural holdings, as well as the main economic indicators (production costs, the gross result, the rate of gross profit etc.) for the agricultural production, in order to elaborate the optimum sizing of agricultural holdings.

Suppose the researcher want to analyze 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:

$$y_t = (\beta_t - \delta_t x_t)\min(x_t, a_{t2}x_t, a_{t3}x_t) \quad (1.1);$$

- 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:

Formulate (1.2)

$$\max \sum_{l} P_l(\beta_l - \delta_l x_l)x_l - \sum_{l=1}^{3} \varpi_l a_{lj} x_i \quad (1.2);$$

subject of the next set of constraintsi :

$$Ax \le b \text{ respectiv } \quad x \ge 0$$

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"*.

The PMP method uses three stages Howitt:

Stage I: The determination of the dual values of "non-constrained" activities of the model. This stage supposes the construction of a LP model which will generate these dual values.

Stage II: The determination of the parameters of the marginal production function. Based on the observed data from the agricultural exploitation or of the analyzed production system and of the dual values determined in the first stage are established the parameters (the slope and the free term) of the marginal production function in the framework of the objective function.

Stage III: The construction of the behavioral simulation model. Based on the parameters of the marginal production function previously determined and on the data observed in the analyzed system (technical-economical coefficients, allocations of surfaces) the PMP model is constructed (1.2). 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.

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	150.2	155.7
Gross margin calculated	Euro/ha	629.62	609.98
Average production	Tons/ha	4.5	4.3
Surface allocated in the base year	Ha	3	2

At the level of this agricultural exploitation it is desired to construct a behavioral simulation model, which can predict for example the agricultural decider's behavior 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.

In order to determine the parameters of the objective function of the model defined by the equation (1.2), a system of two equations is solved depending on the unknown β_l and δ_l of the production function. Be the production function having a quadratic form, like the model 1.2, then the first equation of the system is given by the average production of the crop "*i*".

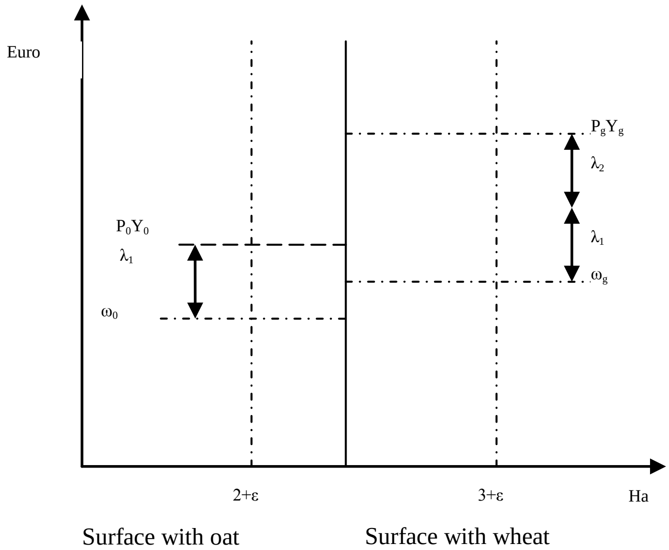

Figure 1 **Cropping plan of the agricultural exploitation**

$$\overline{y_i} = \beta_i - \delta_l x_i \text{ (1.3).}$$

To define the second equation of the system the dual value of the calibration constraints *(λ_2)* will be used. This shadow price is defined to be the difference between the average production value (APV) of the calibrated crop (wheat) and the marginal production value (MPV) of the same crop.

The determination of the two types of dual values λ_1 and λ_2 can be specified for the general case of "k" existing crops in the production of the farm. Matrix A in the model 1.3 is partitioned depending on the optimizing solutions of this model (included in the vector x_B) in a quadratic matrix of rank m, noted with B. The second part of the matrix A will be a matrix of dimension m x (k-m) noted with N. This matrix is associated with the existent k-m crops in the farm and constrained by the calibration constraints (x_N). In the general case the dual value λ_1 is defined as follows:

$$\lambda_1^* = B'^{-1} \Delta_{X_B} f(x^*) \text{ (1.4);}$$

Where $\Delta_{X_B} f(x^*)$ represents the gradient of the marginal value of the production of the non-calibrated activities, determined by the optimization of the model 1.3.

The vector x_B is represented by the land surfaces allocated to the limited crops by the general set of constraints and λ_1 represents a vector of dimension m x 1 composed of the dual values of those *"m"* limitative resources. The equation 1.4 shows that the value of the marginal productivity of the constrictive resources is a function which depends on the income of the activities constrained by this. The most productive activities included in the vector x_N don't influence the dual values of the resources. This principle stated by the model respects the principles of opportunity cost. According to this principle the marginal net income of the last unit of resource used in the production determines the opportunity cost of the respective resource. In the frame work of the models constructed using the PMP the activities with a higher profitability and included in vector "xN" are constrained by the calibration constraints. The less profitable activities represented by vector "x_B" can utilize the supplemental units of resource and thus they determine the opportunity cost of these resources.

The dual values of the upper limits of calibration constraints are determined by using the following equation:

$$\lambda_2 = -N'B'^{-1}\Delta_{Xn} f(x^*) + I\Delta_{Xn} f(x^*) \quad (1.5)$$

Which through the utilization of 1.4 becomes?

$$\lambda_2 = \Delta_{Xn} f(x^*) - N'\lambda_1 \quad (1.6)$$

Behind the equation 1.6 there is the following economical truth: the dual values of the calibration constraints are equal with the difference between the marginal income of the calibrated crops and the opportunity cost of the resources used for the production of the other branches of production.

As a result of the optimization presented above the first term of the equation 1.5 is represents by the value of the average production of the activities included in the vector $x_{N,}$ The second term of the equation is represented by the value of the marginal productivity of the land from the equation 1.4, the difference between the average value and the marginal value of the land is attributed to the different quality of the land.

With the help of the equations 1.4 and 1.5 the dual values of the activities λ_1 and λ_2 are determined and they are graphically represented in the Figure 1.The dual values of the calibration constraints $\lambda_{2\ are}$ equal with the difference between the net average production/ surface unit determined in a linear programming model and the opportunity cost/ surface unit. As the value of λ_1 represents the difference between the average value and the marginal value of the most profitable branches of production and taking into account the specification of a linear function of income in the equation 8, an element of the vector λ_2 can be written as follows:

$$\lambda_{21} = P_1(\beta_1 - \delta_1 x_1) - P_1(\beta_1 - 2\delta_1 x_1) = P_1\delta_1 x \quad (1.7)$$

The slope of the income function can be determined using the above equation in this manner:

$$\delta_1 = \frac{\lambda_{21}}{P_1 x_1} \quad (1.8)$$

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 2.01 hectare. The dual value of the land is 735 Euro and for those two calibration constraints is 41 and 0 Euro. Using equation 1.8 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 1.3:

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

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

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

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

Subject of the next set of constraints:

$$x_g + x_o \le 5$$

A rapid test of calibration of the model against the values of the base year can be achieved by calculating the marginal value for wheat in the case of cultivating of 3 hectare, like in the base year. If the value is close to the marginal value of the out production then the model will calibrate without any supplemental constraints.

Marginal production/ cultivated hectare with wheat is:

$$y/300 = 82{,}76 - 2*0{,}04586*300 = 755{,}25$$

$$VMP_g = 2{,}98*55{,}25 - 130 = 734{,}65$$

The value of marginal production for wheat when 3 hectares are cultivated is 734.65 Euro. This value is lower than the value of the marginal production for oat which is 735 Euro.

CONCLUSIONS

Having in view the subject of the paper – The agro-alimentary integration of the NE Romanian region and the optimization of the size of the agricultural holdings as an effect of the adaptation of the agro-alimentary products to the market's request – we can say that we have to deal with a scientific as well as practical problem and it represents an actual issue for the EU and Romania.

This approach wants to integrate the programs and the papers for a lasting development, where the person is the main character, along with the ecology and the environment, and last but not least a rational exploitation of the resources.

It is well known the fact that the strategy of the countries with a developed agriculture in EU is to encourage and stimulate the producers that stand out thanks to their high quality and economic performance. If Romania wants to be part of the EU structures, the Romanian agriculture must be prepared in order to meet the standards. The criteria for the increase of the profit are based on the specialization of the production, on diminishing the expenses for a product, on the increase of the agricultural production having as main criteria the optimization of the size and of the structure of the holdings through an efficient use of the natural and economic resources. During its evolution, the agricultural exploitation, as a basic unit of the agriculture, gained not only scientific and technical discoveries, but also new ideologies, that stand at the basis of the organizational and management structure, creating efficient systems with a favorable juridical framework for its progress. 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.

At the level of this agricultural exploitation it is desired to construct a behavioral simulation model, which can predict for example the agricultural decider's behavior in the conditions of changing policy of the agricultural loan.

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).

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 average production of the wheat is 776 Euro/ hectare for wheat and 735 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.

The value of marginal production for wheat when 3 hectares are cultivated is 734. 65 Euro/hectare. This value is lower than the value of the marginal production for oat which is 735 Euro/hectare.

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