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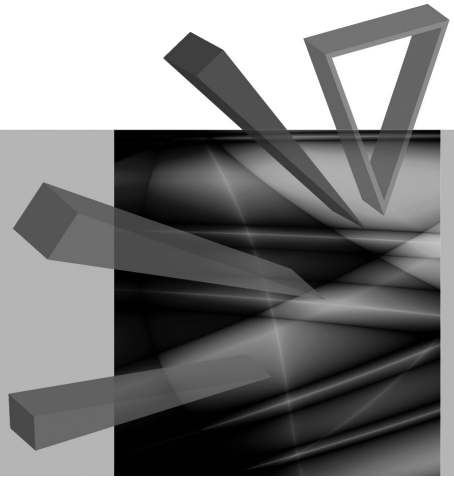

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MANAGING THE PRODUCTION PROCESS OF A GROUP OF AGRICULTURAL FARMS IN THE POMORZE AND MAZURY REGION AND THEIR ECONOMIC DEVELOPMENT

Summary: The aim of this article is an application of the method which enables the maximization of the volume of output on agricultural farms. The research was based on the Pomorze and Mazury region, which was selected after the analysis of the level of gross output, final output and commodity production. For the sake of the study, a group of farms specializing in field crops was selected, using data for 2004–2009, made available by the Polish FADN. The method used for the production optimization is the method of the Lagrange multipliers.

Keywords: agricultural farms, economic development, region.

1. Introduction

Economic development is the term which denotes an increase in various aspects of the standard of human living. Some of them are immeasurable. This means that it covers both quantitative and qualitative changes, bringing on the region from a lower to a higher level of development, which can be related to the concept of economic growth [see Bartkowiak 2003]. It should be noted that optimal production creates opportunities for a faster economic growth, and consequently, for regional development.

Due to the increasing economic disparities between different regions of Poland, it is particularly important to find the means that lead to optimal economic growth. Aligning these disparities is the main objective of the activities of the regional policy [see Churski 2005, p. 13].

It should also be noted that the Polish accession to the European Union, as well as trade liberalization, forced the growth and development of agricultural farms. This is conducive to enlarging their productivity and efficiency, which are the

conditions of maintaining and improving their competitive position. The concept of growth should be understood as the change of the scale of production and the incurred production factors expenditure of the farms, whereas development is a change of the structure of this expenditure [Czekaj, Józwiak 2009, p. 29].

The differences between the regions can be observed on many levels, and this article concerns a branch of the economy, namely agriculture.

Therefore, the objective of this study is the application of the method which enables the maximization of the volume of output on farms. The research is based on the Pomorze and Mazury region, selected according to the analysis of the level of gross output, final output and commodity production. For consecutive study, a group of farms specializing in field crops was used, using data for 2004–2008, made available by the Polish FADN. The method used for the optimization of production is the method of Lagrange multipliers. Broader studies are included in the doctoral dissertation [Barczak 2011].

2. Analysis of the Pomorze and Mazury region

For the analysis of the macro-region, some chosen economic variables based on data from the Central Statistical Office for the period 2004–2008 were used. These include gross output, final output and commodity production.

Gross agricultural output includes [*Rocznik statystyczny rolnictwa*... 2009, p. 49]:

- crop production i.e. unprocessed products of plant origin, harvested in a given year,
- livestock production i.e. the production of animals for slaughter and unprocessed products of animal origin, increase in livestock (livestock – primary livestock and current livestock); the term livestock covers: cattle, pigs, sheep, horses and poultry,
- products from own production, which have been used for production purposes, such as feed, seed, manure.

CSO data does not include agricultural processing, the value of off-farm services and investment and overhauls of the related services [Rychlik, Kosieradzki 1976, p. 110].

The final agricultural output is defined by the CSO as the sum of commodity production value, the natural consumption of agricultural products from own production, the increase in inventories of plant and animal products and the increase in livestock (livestock – primary livestock and current livestock).

Commodity agricultural production is the sum of agricultural products sales to point-of-purchase and on the markets. Commodity production does not include sales between particular legal entities ranked as the same group of entities as well as sales of agricultural products by agricultural production cooperatives to the members of these cooperatives [*Rocznik statystyczny rolnictwa*... 2009, p. 49].

Over the entire study period, gross agricultural output was the lowest in the Pomorze and Mazury region. The highest values were recorded in 2004–2005 and in 2007 in the regions of Wielkopolska and Śląsk and in 2006 and 2008 in the Mazowsze region and Podlasie (see Table 1).

Table 1. Gross output, final output and commodity production according to various regions of Poland in 2004–2008

	2004	2005	2006	2007	2008
	Pomorze and Mazury				
Gross output [in million PLN]*	11 123	11 857	10 726	12 468	14 355
Final output [in million PLN]	8 584	8 979	8 466	9 853	11 021
Commodity agricultural production [in million PLN]	7 453	8 631	8 096	8 882	10 352
	Wielkopolska and Śląsk				
Gross output [in million PLN]	16 385	18 709	16 240	17 850	20 031
Final output [in million PLN]	12 427	14 278	13 072	14 238	15 158
Commodity agricultural production [in million PLN]	10 797	13,199	12,172	12,746	13,538
	Mazowsze and Podlasie				
Gross output [in million PLN]	14 910	16 295	16 353	17 036	21 883
Final output [in million PLN]	10 940	12 373	13 175	13 450	16 517
Commodity agricultural production [in milioln PLN]	9 565	11 004	11 857	11 590	14 599
	Małopolska and Pogórze				
Gross output [in million PLN]	14 464	16 031	14 266	16 462	19 648
Final output [in million PLN]	10 387	11 709	10 978	12 790	14 447
Commodity agricultural production [in million PLN]	8 415	9 783	9 726	10 075	12 081

* Gross output, final output and commodity production are given in current prices.

Source: own elaboration based on the CSO data.

The values of final output looked similar. Over the study period, the final output was the lowest in the region of Pomorze and Mazury. The highest values were recorded in 2004–2005 and in 2007 in the region of Wielkopolska and Śląsk and in 2006 and 2008 in the region of Mazowsze and Podlasie.

The lowest commodity production value was recorded in the Pomorze and Mazury region and this trend continued throughout the entire period under study. The highest value of this production was achieved in 2004–2007 in the region of Wielkopolska and Śląsk, and in 2008 in the region of Mazowsze and Podlasie.

Preliminary analysis based on data published by the Central Statistical Office shows that in the regions of Pomorze and Mazury, over the entire study period, the smallest value of gross output, final output and commodity production, was recorded. Therefore, it seems necessary to analyze production processes on the farms of the Pomorze and Mazury region. Due to the limited size of this article, this is limited to the study of the group of farms specializing in field crops.

3. Methodology of the study

Due to the use of the method of Lagrange multipliers, it should be noted that the non-linear programming task is divided into two groups: without constraints and with constraints (inequality constraints). In both cases the methods for searching for the optimum are iterative numerical methods of solving the non-linear programming task. These methods can be divided into [Pogorzelski 1996, p. 79]:

1) a zero order optimization methods (gradient-less), i.e. those that only search for results on the basis of the value of objective function and constraints if necessary,

2) first order optimization methods (gradient), i.e. those in which in the process of searching for the optimum value, the value of the first derivative of the objective function and if necessary constraints are used,

3) second order optimization methods, in which the Hessian matrix value is used (matrix of second derivatives).

The method of Lagrange multipliers which is used is ranked as the second order optimization method.

Another division (identical as in the case of linear programming) is a division into the programs in canonical form and in standard form. The Lagrange unmarked multipliers method can be classified into programs in canonical form. A characteristic feature of canonical programs is that all the constraints (except for the boundary conditions) are in the form of equations and when it comes to standard programs all constraints are in the form of inequality.

When the objective function is a non-linear function and the constraints are linear functions then the Lagrange function can be used. This is the so called Lagrange unmarked multipliers method.

The production function (objective function) of the form $Y = f(X_1, X_2, \ldots, X_n)$ is maximized (where $X_1, X_2, \ldots, X_n$ are the decision variables) with the following constraints: $F_i(X_1, X_2, \ldots, X_n) \leq b_i$, $(i = 1, 2, \ldots, m)$ and $X_j \geq 0$ $(j = 1, 2, \ldots, n)$.

It is assumed that the functions Y and F_i are continuous functions and that they have the first and second order partial derivatives. Additionally, the production function Y is an increasing function of the variables X_j. It means that $\frac{\partial f}{\partial X_j} > 0$, $(j = 1, 2, \ldots, n)$.

When the balance conditions of the task take the form of equations, the function of variables X_j and multipliers λ_i is created which is called the Lagrange function. It takes the form:

$$L\left(X_j,\lambda_i\right)=f\left(X_j\right)-\sum_{i=1}^{m}\lambda_i\left[F_i\left(X_j\right)-b_i\right], \tag{1}$$

where: $\sum_{i=1}^{m}\lambda_i\left[F_i\left(X_j\right)-b_i\right]$ is a function of resource expenditures which characterizes the use of resources and their constraints. The Lagrange function has the same values (in the area of feasible solutions) as the objective function Y.

A necessary condition for the existence of an extremum is:

$$\frac{\partial L}{\partial X_j}=0,\ \left(j=1,2,\ \ldots,n\right), \tag{2}$$

$$\frac{\partial L}{\partial \lambda_i}=0\ ,\ \left(i=1,2,\ \ldots,m\right)s\ , \tag{3}$$

or:

$$\frac{\partial L}{\partial X_j}=\frac{\partial f}{\partial X_j}-\sum_{i=1}^{m}\lambda_i\frac{\partial F_i}{\partial X_j}=0\ ,\ \left(j=1,2,\ \ldots,n\right). \tag{4}$$

After determining derivatives $\frac{\partial f}{\partial X_j}=\sum_{i=1}^{m}\lambda_i\frac{\partial F_i}{\partial X_j}$ and $\frac{\partial u}{\partial X_j}=\sum_{i=1}^{m}\lambda_i\frac{\partial F_i}{\partial X_j}$, $\left(j=1,2,\ldots,n\right)$ the principle of equality of marginal increments of the product with the cost function is used and more specifically, with marginal increments of expenditure.

The principle means that the condition of optimality of use of the resource is that the marginal increment of the objective function, caused by the increase of expenditure of any of the resource, was equal to the marginal increment of the resource expenditure function caused by the increase of this resource. If $\frac{\partial f}{\partial X_j}>\frac{\partial u}{\partial X_j}$, then it is beneficial to increase the expenditure of j – resource, whereas if $\frac{\partial f}{\partial X_j}<\frac{\partial u}{\partial X_j}$, then it is beneficial to decrease the expenditure of j – resource [Zegar 1974, pp. 124–125].

A necessary condition to achieve the optimal solution is the same marginal increment of the objective function Y for all resources (per unit of resource expenditure).

A necessary condition for the existence of the function's extremum $Y=f\left(X_1,X_2,\ldots,X_n\right)$ can be determined using the following formula:

$$\frac{\frac{\partial f}{\partial X_1}}{\frac{\partial u}{\partial X_1}} = \frac{\frac{\partial f}{\partial X_2}}{\frac{\partial u}{\partial X_2}} = \ldots = \frac{\frac{\partial f}{\partial X_n}}{\frac{\partial u}{\partial X_n}} \cdot \tag{5}$$

A sufficient condition for the existence of a maximum (minimum) of the Lagrange function is fulfilled when the second derivative determined for the values of variables, which meets the necessary condition of the existence of the extremum, is less (greater) than zero.

4. Findings

According to the Lagrange unmarked multipliers method, the production function, which is the objective function, is maximized under the assumption that the level of incurred expenditure on production will not change. Cost functions are the functions of resources expenditure which characterize the degree of their use and their constraints.

Assumptions concerning the continuity of the production function and its constraints, as well as the first and second order partial derivatives, have been met.

Due to the fact that although the obtained results meet all the assumptions, they are not always possible to introduce in reality and that is why this study is limited only to a short analysis of these results. It should be also kept in mind that the solutions given apply to a group of farms which are diverse internally, and in the estimates the average values were used.

Table 2 presents the Lagrange functions built for a group of farms specializing in field crops, where:

X_1 – labour – total labour expenditure – total expenditure of human labour within the farm operational activity, expressed in conversion units of labour in people employed on a full-time basis (2 200 hours/year);

X_2 – land – utilized agricultural area – the total area of land used for agriculture consisting of: land ownership, land additionally leased for one year or longer, the land utilized on the principle of participation in harvesting with the owner as well as fallow and uncultivated land, does not include mushroom cultivation area, additionally leased land for the period of time less than 1 year, wooded land and other land, expressed in hectares;

X_3 – capital – total assets – includes only assets owned by the farmer (fixed assets and current assets) in PLN.

A non-linear optimization method was used to determine the optimal value of expenditure, which enables the maximization of the value of output. The study of the value of second derivatives, under the adopted assumptions, indicates that for this group of farms over the entire period under study, the maximum values were obtained.

Table 2. Lagrange functions for a group of farms specializing in field crops

Years	Model
2004	$L = 19.83X_1^{0.2335}X_2^{0.4195}X_3^{0.5455} + \lambda(-152176.44 + 37579.61X_1 + 1873.41X_2 + 0.0731X_3 - 346794.7)$
2005	$L = 18.85X_1^{0.3251}X_2^{0.3562}X_3^{0.5581} + \lambda(-133558.80 + 27183.30X_1 + 1753.08X_2 + 0.1227X_3 - 472245.0)$
2006	$L = 54.67X_1^{0.3677}X_2^{0.3443}X_3^{0.4789} + \lambda(-93867.33 + 36243.51X_1 + 1983.37X_2 + 0.0948X_3 - 607119.0)$
2007	$L = 64.15X_1^{0.3066}X_2^{0.4729}X_3^{0.4403} + \lambda(-278931.51 + 85546.74X_1 + 1018.27X_2 + 0.2261X_3 - 598424.0)$
2008	$L = 42.28X_1^{0.4044}X_2^{0.4119}X_3^{0.4704} + \lambda(-136702.62 + 48975.27X_1 + 2932.32X_2 + 0.0716X_3 - 634623.0)$

Source: own elaboration based on the Polish FADN data.

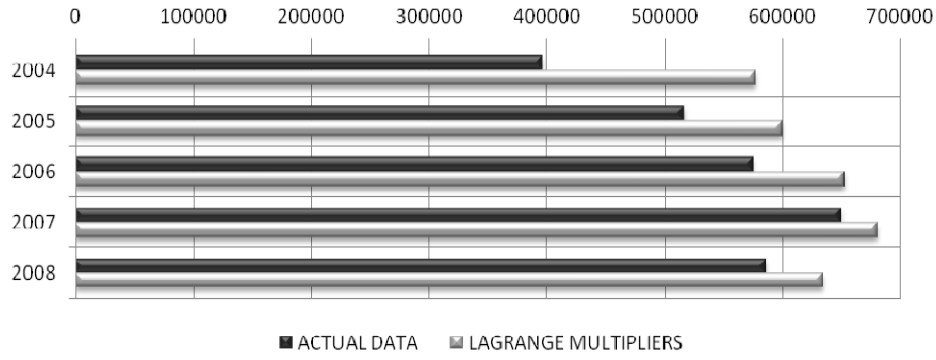

Figure 1. The values of production of the group of farms specializing in field crops, actual and determined with the use of the method of Lagrange unmarked multipliers

Source: own elaboration based on the Polish FADN data.

For the group of farms specializing in field crops, over the entire period under study, the Lagrange unmarked multipliers method generated values of production which are higher than the actual production (see Figure 1).

In 2004, in order to achieve a higher production by 45.59% (180 786.49 PLN), the method suggests a reduction of labour and land expenditure, respectively, by 10.80% (682 hours/year) and 34.76% (49.67 ha), and at the same time, an increase in capital expenditure by 119.29% (1 160 747.17 PLN).

In order to achieve production which is higher by 16.09% (83 195.73 PLN), in the consecutive year, the method indicates the need to increase the labour expenditure by

94.85% (6,270 hours/year) and capital expenditure by 96.27% (1 090 516.64 PLN) and at the same time reduce land expenditure by 47.73% (90.69 ha).

A similar solution was generated for 2006, in which a 13.53% (77 825.48 PLN) increase in production could be achieved by increasing labour expenditure by 49.28% (4,334 hours/year) and capital expenditure by 198.66% (2 972 478.06 PLN) and at the same time reduce land expenditure by 54.79% (123.82 ha).

In 2007, in order to reach a 4.71% (30 628.23 PLN) of increase in production, the method indicated a reduction in employment and capital expenditure, respectively by 14.08% (924 hours/year) and 8.60% (131 818.79 PLN) and at the same time an increase in land expenditure by 74.89% (143.04 ha).

The increase in production by 8.23% (48 230.07 PLN) in 2008, according to the obtained solution, could be reached after the reduction of land expenditure by 53.48% (96.80 ha) and at the same time an increase in labour expenditure by 64.99% (4 290 hours/year) and capital expenditure by 101.36% (1 982 562.96 PLN).

5. Conclusion

The analysis relates to the data from a group of farms of one type. Therefore, the conclusions are preliminary. In order to make them more general, the area of research ought to be expanded to all types of farming. At the same time, it should be kept in mind that the group of farms under study is diverse internally. In order to make the results more meaningful, they should be divided into sub-groups with similar characteristics so that it is possible to minimize the differences.

All things considered, it can be said that the analysis has made it possible to use the method of the Lagrange multipliers which enables the maximization of the volume of output in the group of farms specializing in field crops. Its application in practice can be helpful in the optimization of production in agricultural farms according to agricultural types. The introduction of the method will enable an increase, which is a change in the scale of production, in incurred production factors expenditure and development – a change of the structure of incurred expenditure.

References

Barczak A., *Wykorzystanie metody mnożników Lagrange'a do oceny efektywności produkcji na przykładzie wybranych grup gospodarstw rolnych* (PhD dissertation), IERiGŻ PIB, Warszawa 2011.

Bartkowiak R., *Historia myśli ekonomicznej*, PWE, Warszawa 2003.

Churski P., Czynniki rozwoju regionalnego w świetle koncepcji teoretycznych, [in:] *Gospodarka regionu na Jednolitym Rynku Europejskim. Wybrane zagadnienia*, Zeszyty Naukowe Wyższej Szkoły Humanistyczno-Ekonomicznej we Włocławku. Nauki ekonomiczne, 2005 T. XIX. Z. 3, pp. 13–30.

Czekaj T., Józwiak W., Bariery wzrostu i rozwoju indywidualnych gospodarstw rolnych w makroregionach Polski, *Roczniki Nauk Rolniczych* 2009, seria G, T. 96, z. 4, pp. 29–40.
Pogorzelski W., *Teoria systemów i metody optymalizacji*, Oficyna Wydawnicza Politechniki Warszawska, Warszawa 1996.
Rocznik statystyczny rolnictwa. Roczniki branżowe, GUS, Warszawa 2009.
Rychlik T., Kosieradzki M., *Podstawowe pojęcia w ekonomice rolnictwa*, PWRiL, Warszawa 1976.
Zegar J.S., *Wybrane zagadnienia rachunku ekonomicznego w rolnictwie*, Szkoła Główna Planowania i Statystyki, Warszawa 1974.

ZARZĄDZANIE PROCESEM PRODUKCJI GRUPY GOSPODARSTW ROLNYCH REGIONU POMORZE I MAZURY Z UWZGLĘDNIENIEM POZIOMU ROZWOJU GOSPODARCZEGO

Streszczenie: Celem niniejszego opracowania jest zastosowanie metody umożliwiającej maksymalizowanie wielkości produkcji w gospodarstwach rolnych. Przeprowadzone badania dotyczą regionu Pomorze i Mazury, który został wybrany po dokonaniu analizy poziomu produkcji globalnej, końcowej i towarowej. Do badania wybrano grupę gospodarstw rolnych specjalizujących się w uprawach polowych, wykorzystując dane za lata 2004–2009, udostępnione przez Polski FADN. Metodą wykorzystaną do optymalizacji produkcji jest metoda mnożników Lagrange'a.

Słowa kluczowe: gospodarstwa rolne, rozwój gospodarczy, region.