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POSSIBILITIES OF IMPROVEMENT OF ECONOMIC RESULTS BY CHANGING THE TYPE OF PRODUCTION IN AGRICULTURAL ENTERPRISES[1]

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Summary

Serbia is characterized by a very low consumption of meat and meat products, and constantly depends on import of agricultural and food products. One of the reasons for low consumption of meat in Serbia, in addition to a low standard of living, are the lack of production and supply of meat, resulting in occasional shortages and considerable fluctuation in prices of meat during the year.

The goal of this paper is to explore the possibilities for improvement of economic results by changing the type of production in agricultural enterprises. Observed agricultural enterprise is focused solely on intensive crop production, with all the necessary machinery for its organization, and includes large functional objects for fattening pigs.

The method of linear programming is used to optimize the production of this agricultural enterprise in function of maximizing gross margin. Obtained solution and post-optimal analysis showed that the change of the type of production is cost-effective in economic terms, as in the terms of rational use of available capacity. This model represents one of the specified ways to improve and increase livestock production in Serbia, as well as the possibility to increase employment and income of labor in rural areas.

Key words: *crop production, fattening, optimization, economic results*

JEL classificatio*n: Q12, C61*

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1. Introduction

Favourable natural conditions, good geographical location, large acreage available, the capacity of the agricultural production not only meet domestic needs, but also enable the export are the most important preconditions (characteristics) of agriculture of the Republic of Serbia. However, in addition to the above features, Serbia is characterized by a very low consumption of meat and meat products, and constant dependence on import of agricultural and food products.

The development of agriculture of a country can be measured by participation of livestock production in the structure of agriculture. The share of livestock in Serbia is about 41.3%, with a tendency of decrease by about 2% per year. Observed period (years 2006-2011) is characterized by the total reduction of livestock as follows: 165 thousand cattle, 491 thousand pigs and 74 thousand sheep. During the six-year period, only the number of poultry increased by about 2.5 million individuals.

The diet of the population in Serbia is traditionally dominated by pork. The amount of pork in Serbia used as food amounts to 24.8 kg per capita, while other less common types of meat (beef 9.7 kg, 8.2 kg of poultry meat, sheep meat and goat 2.5 kg per capita annually).

On the basis of the consumption of about 45 kg of meat per capita annually, Serbia is at the bottom of the list of European countries, with an average of about 71kg, while in the EU the average consumption of meat per capita per year is about 80kg.

One reason for this low consumption of meat in Serbia, in addition to low standards, is the lack of production and supply of meat, resulting in occasional shortages and large fluctuation in prices of meat in a year.

The consequences of poorly managed privatization and destruction of livestock production in most privatized agricultural enterprises, and lack of long-term agricultural policy directly have caused the reduction of the production volume of animal products, especially meat. According to some sources, Serbia now has 30.000 - 40.000 buildings that are empty, and are suitable for fattening of pigs and cattle (*Nataša Kljajić et al., 2009*)

In the period from year 2006 to 2011, the average production of fattening pigs was about 934,000 animals a year, ranging from 1.132 million head in the 2006 to 864,000 animals in the 2011. Within six years, the annual production of pigs in Serbia decreased by 268,000 head, or almost 24%. For Vojvodina, even greater reduction in the number of pigs is noticeable, by almost 28% (from 592,000 heads in 2006 to 430,000 heads in 2011). Extremely unfavourable tendencies are characterized by an average annual rate of decline of –4.15% per year (*Novković et al., 2011*).

2. Research subject and objective

The research subject presented in this paper is the agricultural enterprise of plant crop orientation that is characterized as follows:

- located in the plains;
- natural conditions allow the organization of intensive crop production;
- disposes with 1002 hectares of arable land of uniform quality and optimal lot sizes;
- engaged in intensive crop production;
- is well equipped with the necessary means of mechanization;
- there is an opportunity to engage the required number of seasonal workers;
- arable land exclusively used for the production of grain and industrial crops;
- the whole arable land has been engaged in market-oriented agricultural production;
- there are constructed and unused capacities for pig fattening and all the necessary resources for the organization of intensive livestock production.

The aim is finding the opportunities to increase economic performance through better use of available resources and by introducing new production lines. Using modern optimization methods, patterns of production have been established in observed agricultural enterprise, such as: optimization of the existing structure of crop production and the optimization of the production structure by introducing of new crop lines for the production of concentrated animal feed in the function of change of the production direction, that is introduction of pig fattening enterprise. Pig fattening, as a new line of livestock production, is introduced in order to utilize existing available capacities of the enterprise intended for fattening of pigs, spare capacity in form of existing mechanization and available capacity of full-time employees.

3. Method

For the realization of the set goal, i.e. to optimize the production structure of the observed agricultural enterprise, the method of linear programming was used in this study.

Linear programming models are designed for the determination of the optimal solution, which provides an extreme (maximum or minimum) value of the defined criteria (objective). Programming model is formulated on the basis of quantitatively expressed limiting conditions (extent of available resources), technical coefficients (resource use per unit of production), and aims, while there are several possible solutions (different technologies, different possible structures of production) to choose between.

In mathematical terms, the general linear programming problem consists in finding the optimum (minimum or maximum) linear functions, with "n" independent variables Xi (i = 1,2,3, ..., n) connected by linear relations (equations or inequality), and limiting conditions.

a) the objective function

$$Z=C_1X_1 + C_2X_2 +.....+ C_nX_n \rightarrow \max \quad (1)$$

or

$$V=C_1X_1 + C_2X_2 +.....+ C_nX_n \rightarrow \min \quad (2)$$

Where:

X_i – unknown independent variable value, i=1..n

C_i – coefficient of the objective function,

Z – maximum of the objective function

V – minimum of the objective function

n – number of unknown values in the model

i=1..n

b) matrix of the limiting conditions

$$a_{11}x_1 + a_{12}x_2 +.....+ a_{1n}\, x_n \leq b_1 \quad (3)$$

$$a_{21}x_1 + a_{22}x_2 +.....+ a_{2n}\, x_n \leq b_2 \quad (4)$$

$$a_{m1}x_1 + a_{m2}x_2 +....+ a_{mn}\, x_n \leq b_m \quad (5)$$

$$x_1, x_2, ..., x_m \geq 0; \quad bj \geq 0 \quad (6)$$

Where:

b_j – available resource,

a_{ij} – technical coefficient of the independent variable,

m – number of limitations in the model,

j=1..m

c) non negativity condition $Xi \geq 0$

By specifying the values of unknown variables Xi which satisfy the mathematical constraints in the matrix of limiting conditions, realization of extreme values of the objective function is achieved.

In economic terms, linear programming is a mathematical technique for the deployment and use of limited funds and resources in order to define the best plan for their use as defined in the predetermined objective, such as the maximum income and minimum cost.

When compiling simplex table used as starting point in solving a given problem of optimization as the criterion of the objective function, the gross margin for all present production lines is used. The calculation of gross margin was made on the basis of average yields and actual consumption of direct and auxiliary materials for the period 2008-2012. All indicative values were calculated using constant prices from year 2012.

Limiting conditions in the proposed model are determined based on crop rotation and budget of manpower and machinery using the method developed in the research by Nikolić (*Nikolić 1984*). Technical coefficients are expressed through hours of labour and mechanization per month during the vegetation period for individual production lines, in accordance with the applied technology and agrotechnics in production of field crops in the company.

4. Results and Discussion

For the study, based on the methodology proposed in this paper, two research models were constructed.

The resulting optimal solutions were compared with the average of the results achieved in the previous five-year period (from 2008 to 2012) calculated using the fixed price of the year 2012.

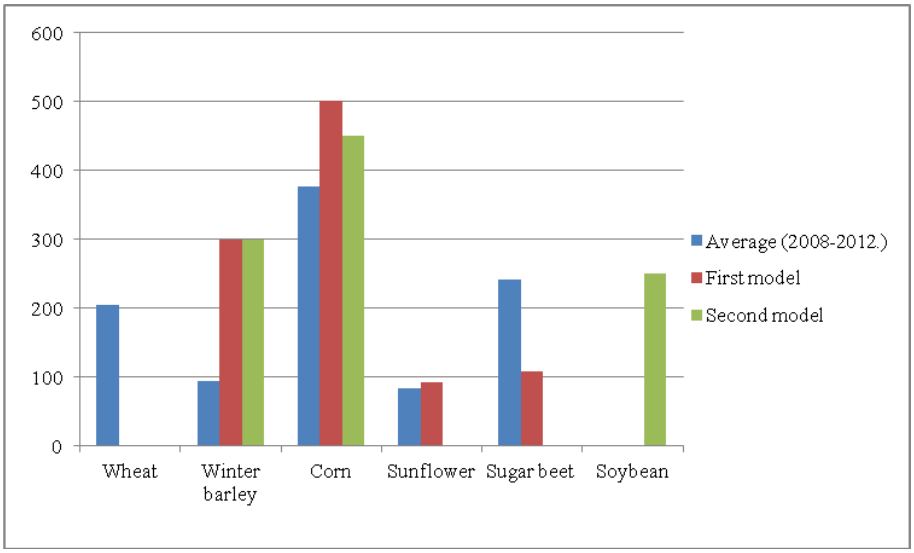
The first model was constructed in order to determine the optimum seeding structure for already existing crop production lines represented in the 2008-2012 period.

The second model introduces as an additional activity the pig fattening line and soybean production line as the main protein feed for the preparation of concentrated mixtures for nutrition of pigs. In this model, the structure of crop production management is determined by the pig fattening line. The starting point was the assumption to provide from their own production the necessary components for preparation of animal feed intended for feeding of pigs, which are then sold on the market.

The calculation of gross margin in the production of pigs was made based on composed pig diet, average market prices of piglets and fattening pigs and performance of employees. Concentrated mixtures used in the feeding of pigs were based on their own production of maize, winter barley and soybean. Soybean produced on the company's own areas was delivered to the processing facilities in

a parity exchange for soybean meal. As the essential ingredients of feed mixtures only pre-mixes were purchased on the market.

Average actual structure of agricultural production in the period 2006-2012, as well as obtained optimal structures of crop production, by solving the first and second model, presented graphically (Graph 1)



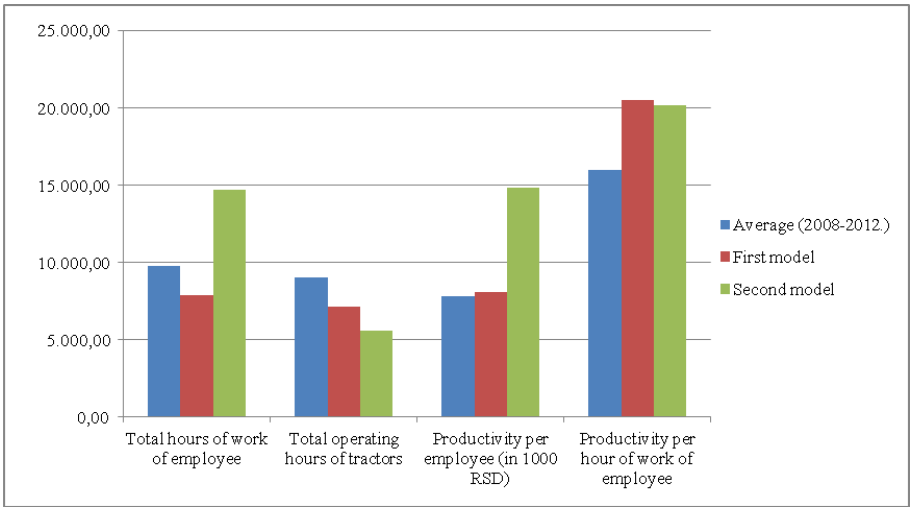
Graph 1 Average and optimized structure of sowing

Optimal seeding structure of the first and second model differs significantly from the average actual structure of crop production in observed agricultural company. In the first model, the wheat was not included in the optimal structure of sowing, but instead the winter barley was included, primarily due to the gross margin realized in this production. At the same time, in the first model, the share of maize (32%) and sunflower (11%) increased, while the share of sugar beet in the sowing structure was reduced (by 45%). Thus these crops fully satisfied the restrictions related to crop rotation. In the first model, the limitation of labour and of operation of medium size tractors were completely fulfilled only in October, as a month with the highest work peak in the company. The received gross margin in the first model was by 3.7% higher than the gross margin of agricultural enterprise that was obtained based on the average sowing structure generated in the observed period.

Optimal seeding structure of the second model fully satisfied the set limitations in regard to the crop rotation of soybean and winter barley. This is because these two lines, in addition to maize, are intended exclusively for preparation of concentrated meals for feeding of fattening pigs. For other crops limitations relating to crop

rotation were satisfied with 90% in maize, while in this model, wheat, sunflower and sugar beet were not entered in the optimal structure of sowing because they are not related to the preparation of animal feed, through which far greater gross margin is achieved, but were intended for sale in the market. The resulting solution allows fattening of pigs on 4303 places in one production cycle, and the total annual fattening of 14.632 pigs. Achieved total gross margin in the second model, is by about 83% higher than the gross margin in the first model.

In addition, for evaluation of economic efficiency of the tested models other indicators were used, such as: realized gross margin per hectare, realized gross margin per employee and labour productivity expressed in gross margin per hour of work of employees.



Graph 2 Realized economic indicators

Bearing in mind that in the first model the structure optimization of existing production lines was performed, it can be concluded that with the increase in total gross margin of the company, a reduction in total hours of workers and tractors by about 20% occurs, compared to the average work hours that company had in the period 2000-2012.

Due to the introduction of labour-intensive production of pig fattening, in the second model, the total increase in gross margin was accompanied by the increase of the total operating time of workers by about 51%. In addition, because sugar beet, as the most labour intensive crop, was not included in the optimal structure of sowing, engagement of tractors was reduced by about 39%, compared to the

average hours of tractor operation that was recorded in the company in the period 2000-2012.

The level of actual labour productivity expressed as gross margin per hour of work of employees in the first model increased by 28.3%, and in the second model by about 26.4% compared to the average productivity achieved in the company in the reporting period of 2008-2012.

5. Conclusion

Based on the research results obtained, it can be concluded as follows:

- Optimization of existing production structure in the observed agricultural company, total gross margin can be increased by 3.7% compared to the average achieved in the five-year period;

- Changing the direction of production and by the introducing the pig fattening and production of basic nutrients for preparation of animal feed on their own land, instead of production of crops for the market, resulted in the increase of the total company gross margin by approximately 83% compared to the average achieved in the observed period;

- The efficient utilization of existing capacities (now empty and deserted) for fattening pigs in agricultural enterprises can significantly improve the economic results of business operations, increase the employment of workers and thereby significantly stabilize the domestic swine and pork market.

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