Linear Programming in Agriculture: Case Study in Region of Development South-Mountenia

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ABSTRACT

In agriculture, the production structure of farms can be highly diversified to reduce risk and uncertainty related to unsealing the products. To determine the optimal structure of crops, different methods which take into account the income and expenditure of crops per hectare are used. As a result, the area of each crop is identified, so that, in combining them to derive maximum profit level. In this paper, linear programming method is used for optimizing profit, investigating whether, after applying the econometric model, the profit increased or not. The results show that profit rose to 143% and costs reduced to 81%.

Keywords: Agriculture, Econometric Model, Linear Programming, Profit, Structure of Production

INTRODUCTION

The paper investigates the economical activity of a vegetal farm and to optimize its profit using linear programming method. The research question is whether after applying the econometric model the returns of the economical activity is higher or not.

Optimizing crops’ structure using linear programming is widely applied in economical research. As it is all known, in literature linear programming (Kantorovich, 1987; Dantzig, 1963; von Neumann, 1954) as a specific methodology was developed by Leonid Kantorovich, a Russian mathematician who developed linear programming problems in 1939, George B. Dantzig, who published the simplex method in 1947, and John von Neumann, who developed the theory of the duality.

The work of Dantzig (1963) is recognized to be the most applicable. His original example of finding the best assignment of 70 people to 70 jobs exemplifies the usefulness of linear programming. With the help of computers, it takes only a moment to find the optimum solution by posing the problem as a linear program and applying the Simplex algorithm. The theory behind linear programming drastically reduces
the number of possible optimal solutions that must be checked.

Nowadays, many changes have transformed the landscape of optimization methods and software since Dantzig, because of the Internet and the World Wide Web facilities. Gill et al. (2008) considers that it is no longer necessary for the critical mass of people to be co-located, since researchers and users can exchange code electronically as well as run problems on a machine in a remote location using software written by someone else. Even so, Dantzig’s concept of a systems optimization laboratory lives on.

Linear programming is used in all fields, including agriculture. Montazemi and Wright (1982) applied mathematical programming in agriculture, as an example of the use of operational research in developing countries. Researchers (Voicu et al., 2010; Dobre et al., 2011; Istudor et al., 2007) show the Romanian contribution to the field.

This paper is a practical approach to the method of linear programming. The relevance of outcomes consists in the opportunity of using this methodology for maximizing profits of farms, by changing the structure of crops.

Material and Method

To optimize farm profits, the linear programming method to data supplied by a farmer has been applied. Linear programming is a mathematical method for determining a way to achieve the best outcome (maximum profit or lowest cost) in a given mathematical model for some list of requirements represented as linear relationships. Linear programming is a specific case of mathematical programming. More formally, linear programming is a technique for the optimization of a linear objective function, subject to linear equality and linear inequality constraints.

The econometric model maximizes the profit function and it is expressed by the following relationship:

\[
\text{max. } f(x) = \sum_{j=1}^{n} p_j x_j , \quad j=1, 2, \ldots, n
\]

The model constrains are:

1. \( \sum_{j=1}^{n} a_{ij} x_j \leq b_i \)
2. \( x_j \geq 0 \)

Of which:

- \( x_j \) – area of crop \( j \)
- \( p_j \) – profit of crop \( j \)
- \( a_{ij} \) – resource consumption per unit of production for crop \( j \);
- \( b_i \) – the volume of resources;
- \( j \) – set of crops;
- \( i \) – volume of crops.

Data have been collected from a farm whose object of activity is complex, containing numerous branches (crops), planted within ecological system. A diversified business structure has the advantage of reducing the effects of risk and uncertainty, but it cannot be overlooked the pronounced fragmentation of the area cultivated.

1. PHYSICAL RESOURCES OF THE FARM

1.1. Land Resources

The farm has an area larger than what is, on average, a unit of the Romanian agriculture conditions and fall in the average size of farms found in the EU area. Most of the agricultural area (93.6%) is arable land, since the holding is found in the lowlands. The plot is characterized, given its location, a good fertility, both field crops and vegetables are favourable (Table 1).

1.2. Technical Facilities

In such a physical dimension of the farm, it is natural that the technical endowment to be proportionate to the volume of working, especially if the farm doesn’t provide services to other farms. Land load per tractor is 47 hectares. The existing technical facilities (Table 2)
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