PRODUCTION MANAGEMENT USING MARKET INFORMATION-CASE STUDY FOR FOOD INDUSTRY

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ABSTRACT: The paper presents certain aspects regarding a method based on using market information in production management. The production activities referred to in this paper belong to the field of food industry. The product market in this field is dominated by intense competition. The paper presents a practical method that allows, based on market information about supply and demand, the contribution of a unit of labor in total production be identified by marginal production.
Keywords: market, demand, production management, marginal production

1. THE CONCEPT OF PRODUCTION

In general, any activity that creates value may be called "production." Since the actual processing work best illustrates the production process, discussions will focus on this type of situation (the actual processing). Viewed globally, production is a set of activities through which the resources used as inputs (raw materials, labor, technology, capital, land, managerial skills) generate outputs that can take the form of goods or services, Figure 1.

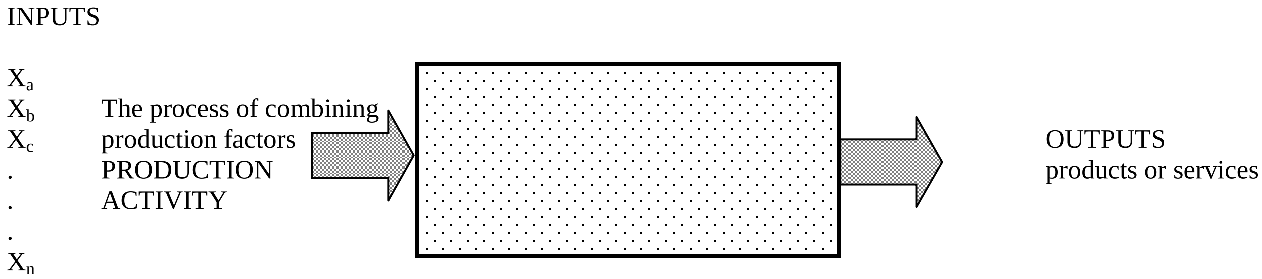

Figure 1. Production as a System

The mathematical expression of the relationship between inputs and outputs (production technology) is called the production function (total). The production function shows the total number of product units made by input units (factor of production). Economists use the production function to refer to the relationship between the factors of production (raw materials, labor, capital, land, knowledge, managerial talent, entrepreneurial skills) that are inputs into the process and the results of production activity represented by economic goods and services.

The mathematical relationship can be expressed as:

$$Q = f (Xa, Xb, Xc, ..., Xn),$$

Where

Xa, Xb, Xc,..., Xn,

represents quantities of different types of inputs and Q quantity or volume of production over a period of time. The input-output relationship is dependent on both the quantities of factors of production in the process and their way of combination (manufacturing technology adopted by the company). A company can change the volume of production either by changing the quantity of used inputs, or by changing the used manufacturing technologies. The efficiency of production techniques determines the final outcome of the production process and the technological know-how determines the number of available techniques.

In the long term, the competition and the incentives brought by profit give the company the desire to invest in the most efficient available technologies. In the short term, the company tries to use the existing technology in order to obtain the aggregate output in any alternative combination of inputs that could be selected.

For this type of production function

$$Q = f (Xa, Xb, Xc, …, Xn),$$

value of Q that corresponds to certain numerical values of variables Xa, Xb, ..., Xn is interpreted as being the highest production value to be achieved in terms of using a certain production technology adopted by the company.

Achieving the maximum efficiency in production by using a certain production technology requires the acquisition of a maximum production volume being given a certain combination of inputs or minimizing the volume of factors of production used to produce a certain amount projected by economic results. As long as a company uses the most efficient available technology, the level of the achieved production depends on the quantity of factors of production employed in the process and on their efficiency. A company may use the production function to find answers to the following questions:

What will be the achieved production if the quantity used in a factor of production is increased while the other factors of production are constant?

What will be the achieved production if the quantity used in a factor of production is increased while the quantity used in other factor of production is reduced?

What will be the achieved production if the used volume of some inputs increases while that of others falls?

Short-term and long-term production

Inputs in the production process are classified into fixed and variable inputs. A fixed input is defined as one whose quantity can not be changed for a short period of time to change the level of economic results of productive activity. Few entries are rigid, fixed, even for a very short period of time. Practically speaking, the cost of changing an input may be prohibitive. Changing the quantity of a factor of production may be seriously hampered by the currently used technology, the impossibility of supplementing the quantity of a particular factor of production or the time the achievement of certain changes of use takes. Fixed inputs in the production process are considered to be the equipment and the machine tools, the space available for production activity (buildings) and managerial and technical know-how.

The variable inputs into the process are those inputs whose levels of use can be easily modified as a response to the desire of changing the production volume. The production factors whose volume can be easily modified for a short period of time are electricity, most raw materials, transport services, the number of workers directly employed in production, and support staff.

In economics, the short period of time is the time when the company is constrained to maintain a constant quantity of fixed used inputs, such as production equipment, management, technology and the space needed for production activities. A short period of time is considered the time interval which is so short that the quantity of fixed inputs cannot be changed. In addition, the short period of time is long enough to allow the modification of variable inputs. Therefore, the productive capacity of the firm must be achieved exclusively by changing the uses of variable inputs.

Instead, the long period of time is defined as being that period that is long enough to allow for changes to all the inputs. No input in the production process is kept constant, including technology. Thus, for a long period of time, capacity can be modified by changing manufacturing technologies or the level of input use in any manner that could be profitable for the company. For example, while in the short run, a company may be forced to expand its production capacity by using high rates of use, in the long run the company may consider building large production facilities or install additional inputs in order to avoid overloading staff.

The short term production function indicates the level of economic results that may be obtained by combining different variable inputs, maintaining fixed inputs constant. The average production of variable inputs is the average amount of production obtained per unit of variable input used and is calculated as ratio of volume of production achieved and the number of variable inputs used to obtain the production in question. The average production of variable inputs is the average amount of production obtained per unit of variable input used in the production process and is calculated as ratio of volume of economic outcome achieved and the number of fixed input units. The mathematical expression of the average production function of the fixed inputs is:

$$PM_{IF} = Q/IF.$$

2. MARKET SITUATION ANALYSIS

Starting from the product demand of ESAROM ROMANIA we have analyzed a specific product: "toppings." This product is an important component of the company's production because its market share exceeds 60%.

In order to obtain a perspective upon the market we started from the price-quantity relationship in the case of toppings required for a period of time and with dedicated software applications we have obtained demand through linear regression programs, Figure 2:

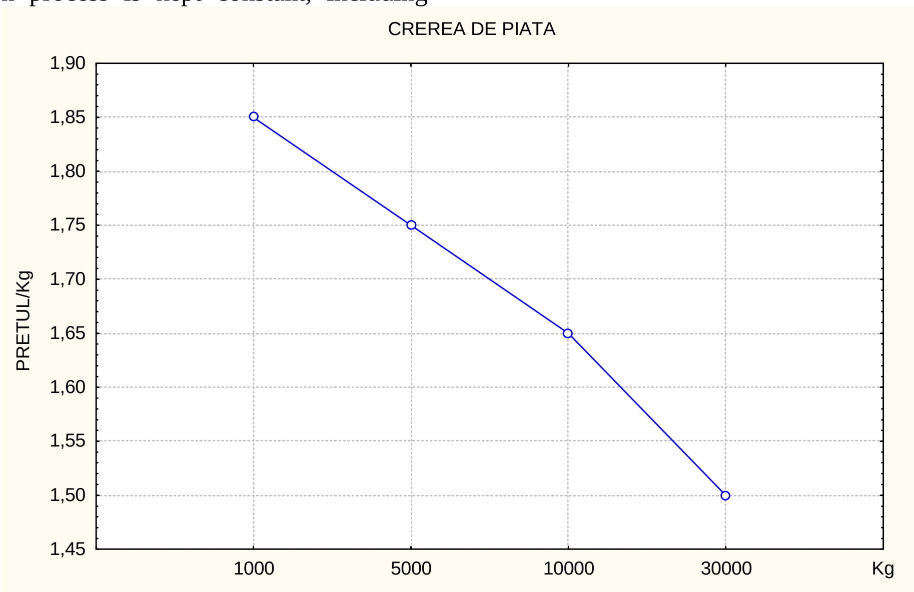

Figure 2. Topping Demand

The total amount requested by the market for a period of time was 333.49 tons. ESAROM ROMANIA covered a 60% market share which corresponds to a quantity of 200 tons for one year. For the analysis of toppings demand in terms of price elasticity we modelled the demand and related turnover. Their graphical representations are shown in figures 3 and 4.

The demand is required to identify the value of the quantities required and absorbed by the market over a period of time. The market absorbs from the production achieved certain quantities, depending on the rhythm imposed by competition. The linear model of demand for toppings is further analyzed in terms of price elasticity to see how much of it is actually met by the supply of ESAROM ROMANIA. If the supply meets demand in areas where elasticity are higher than 1, the turnover increases and the demand increase brings benefits to ESAROM ROMANIA. If supply meets demand on areas with elasticity lower than 1, then supply must be reduced in order to increase turnover. Supply reduction is similar to the increase in market price and this depends on the competition itself. Because high levels of quantities requested by the market are used, the slope of the straight line of demand is low, and the point of unitary elasticity is about 0.8 Euros/Kg of pittings. This value is unlikely to be achieved in market transactions.

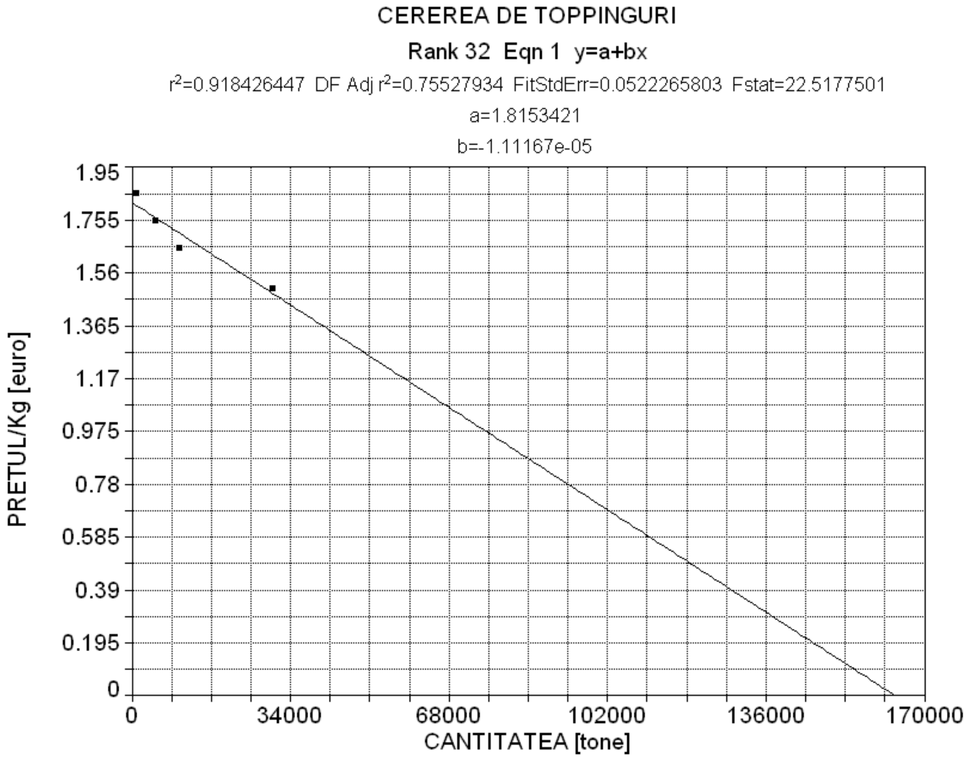

Figure 3. The mathematical model of the demand for toppings

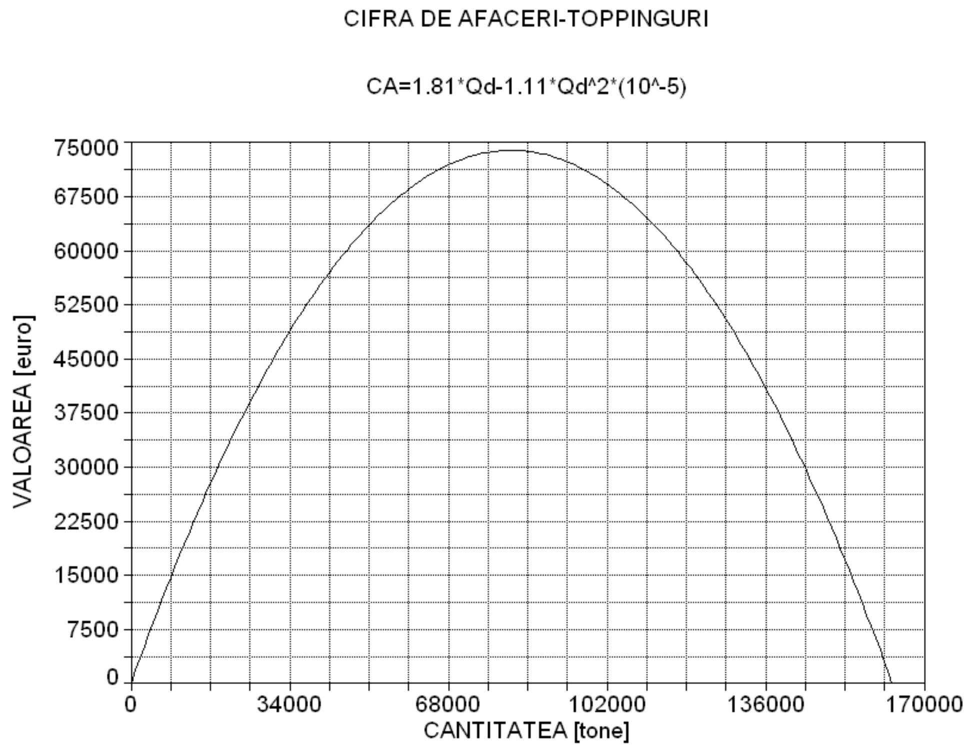

Figure 4. Toppings turnover

For the calculation of turnover by means of the demand, we obtained a demand model as a function of dependence of price on the amount requested as follows:

The expression corresponding to Figure 3 is:

P=1.81-1.11*Qd*10^(-5) (1)

Turnover based on price and quantities required will be:

CA=P*Qd, (2)

Where:

CA is turnover, P-price per Kg, Qd - quantity at difference prices.

If we replace in (2) the price P with the expression obtained by regression: relation (1)

P=1.81-1.11*Qd*10^(-5),

the turnover formula shall be obtained as follows:

CA=(1.81-1.11*Qd*10^(-5))*Qd==1.81*Qd-1.11*Qd^2*10^(-5). (3)

By means of the turnover expression, one may obtain its image which then might be placed near the image of the demand to see the effect of ESAROM ROMANIA's supply on earnings.

The turnover expression is a parabolic function with branches down as shown in figure 4.

The analysis of delivered price-quantity relation, based on demand (Fig. 3), showed that this was accomplished at demand elasticities higher than 1 in relation to price. The relation for calculation is:

$$\varepsilon_P = \frac{dQ_d}{dP} \times \frac{P}{Q_d} = \frac{1}{\frac{dP}{dQ_d}} \times \frac{P}{Q_d}. \quad (4)$$

The price derivative shall be calculated in relation to Qd.

$$\frac{dP}{dQ_d} = -1{,}1 \times 10^{-5}. \quad (5)$$

By substituting in the demand expression the price values : 1.85 Euros / kg, 1.75 Euros / kg, 1.65 Euros / kg, ie 1.50 Euros / kg the following quantity values are obtained intake values are obtained: 12,625t; 18,018t; 27,027t, respectively 40,540t,

Calculating the elasticity of demand in relation to price by means of formula (4), it shall be:

- For the price of 1.75 Euro / Kg,

$$\varepsilon_P = \left| \frac{1}{-1{,}1 \times 10^{-5}} \times \frac{1{,}75}{18.018} \right| = \left| -8{,}82 \right| > 1 ,$$

The analysis of turnover and demand situation, Figures 3 and 4, show that there is a "cluster" of price-quantity values in the area with demand elasticity higher than 1. On this segment, the turnover is growing which means that ESAROM ROMANIA has made the right choice by increasing supply, providing higher quantities for lower prices. The turnover reaches the maximum value at around 85,000 tons.

2.1. Total and marginal product

Considering the profitability of the activity related to the product toppings, we obtain a perspective upon the quantities for which production activities should be developed. The production is "short term" because there are fixed inputs and they are represented by toppings production line with a maximum production capacity of:

• 1.5 tons/ batch/ 4 hours - with 2 operators; = 3 tons/8 hours= 9 tons/ 24 hours,

• 1.5 tons/ batch/ 3 hours - with 4 operators = 4 tons/8 hours = 12 tons/24hours.

The production analysis shall be performed in terms of ensuring the maximum quantity required by the market over a given period, the optimal combination of labor and technical capital - the production line for toppings.

Starting from the cost value TC = 200,000 Euros, from labor costs and the number of operators the straight line of constraint may be drafted:

$$TC = P_L \times L + P_K \times K , \quad (6)$$

PL is the price of labor, L-number of employees, PK the price of capital and K the number of workstations on the toppings line.

The situation of ESAROM ROMANIA in terms of constraints shall be:

$$200000 = 343 \times L + 16600 \times K .$$

The combination of labor and capital resources may be achieved in a very high diversity, but the problem is to find the optimal combination. Once made, the investment is to be loaded at full capacity: 24 hours a day. The quantity of pittings required on the market at a certain time shall be the condition on which total production depends.

In the short term, as the situation of pitting production can be characterized, variable inputs are represented by the workforce.. Starting from work rules and work results assessment the pitting total production model can be obtained. A 3rd rank polynomial model was chosen because it approximates reality well and can be easily processed both analytically and graphically.

The total product as function dependent on the input variable - labor is shown in figure 5.

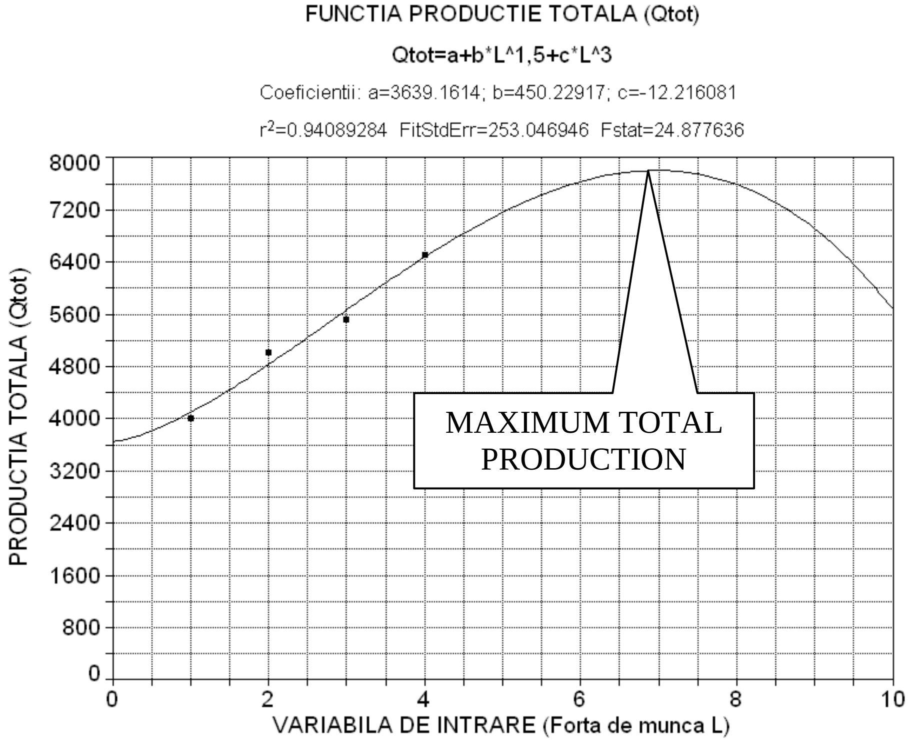

Figure 5. The total production function

The maximum total product is obtained for L=7 and has a value of 7820 tons. The total product has a rapidly growing segment, it increases with a growing rate up to the value L=3. After this value, the total production increases but the growth rate is gradually lower, to the point where total product is maximum and marginal product is zero. Beyond this point, the continuation of production has no economic support, the contribution of a unit of labor becomes negative.

A dynamic picture of the evolution of the total production in relation to the input-labor variable is obtained by marginal product - PM. This is obtained from the expression of total product derived in relation to L as follows:

$$PM = \frac{dQtot}{dL} = \frac{d}{dL}(3639 + 450 \times L^{1,5} - 12 \times L^3) = 600 \times L^{0,5} - 36 \times L^2$$

The graphical representation of marginal product is shown in Figure 6. One can see that the marginal product is zero for L=7. This means that the maximum number of labor must be 7 employees for the pittings line, over this value employees' contribution to the total product is negative.

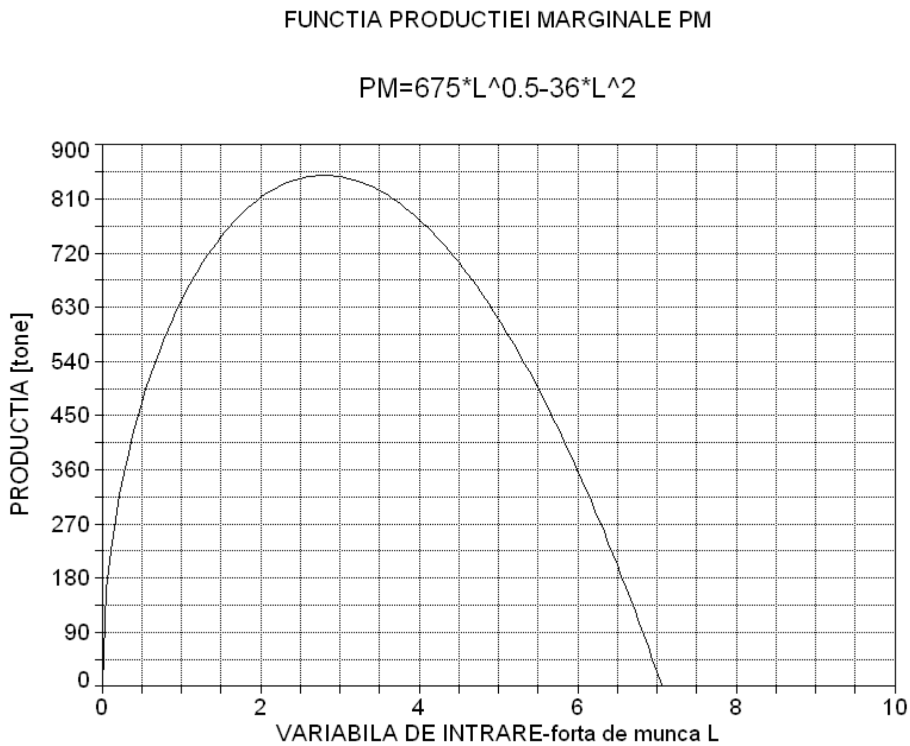

Figure 6. Marginal product

Marginal product has a rapidly increasing trend, which means that the contribution to total product of the first employees is significant. After 3 and moreover after 4 employees, the contribution of each of the employees is increasingly smaller, the total production increasing. For the variable input L=7 employees, the marginal product is zero.

In order to easily observe the connection between total and marginal product we represented them on the same graph, figure 7.

The graph shows that on the segment on which marginal product is increasing the total production is increasing with an increasing rate. After the marginal product peaks (L=3), total product continues its growth but with a decreasing growth rate.

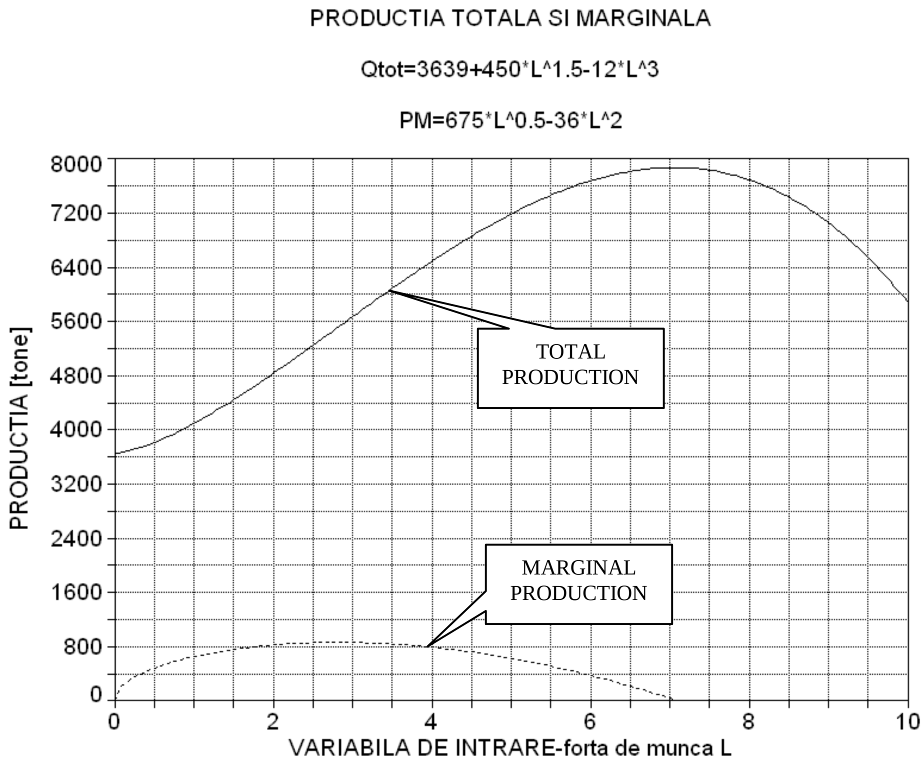

Figure 7. Total and marginal product-pittings

Average product relative to the input variables is obtained as the ratio between total product and input variable L.

$$PM_L = \frac{Qtot}{L} = \frac{3639 + 450 \times L^{1,5} - 12 \times L^3}{L} = \frac{3639}{L} + 450 \times L^{0,5} - 12 \times L^2.$$

By comparison with the marginal product, the average production is slower.

3. CONCLUSIONS

• For an efficient management of production a good knowledge of the market in terms of supply and demand is required;

• Reducing production costs provides the company's management with reserves in the profit per unit of product, the company earning an increase in demand, namely an increase in turnover from lower prices and larger quantities sold;

• The use of modelling allows the ESAROM ROMANIA management to accurately monitor the components of profit in their dynamics and evolution thus avoiding undesirable situations;

• Marginal analysis of production function represents a very useful tool in achieving the optimum combination of labor and capital resources.

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