

SUBJECT- MANAGERIAL ECONOMICS

M.COM- 4TH SEMESTER

TOPIC : Production Function and The Law of Variable Proportions

Introduction:

In traditional production theory resources used for the production of a product are known as factors of production. Factors of production are now termed as inputs which may mean the use of the services of land, labour, capital and organization in the process of production. The term output refers to the commodity produced by the various inputs.

Production theory concerns itself with the problems of combining various inputs, given the state of technology, in order to produce a stipulated output. The technological relationships between inputs and outputs are known as production functions.

Production in economic terms is generally understood as the transformation of inputs into outputs. The inputs are what the firm buys, namely productive resources, and outputs are what it sells. Production is not the creation of matter but it is the creation of value. Production is also defined as producing goods which satisfy some human want. Production is a sequence of technical processes requiring either directly or indirectly the mental and physical skill of craftsman and consists of changing the shape, size and properties of materials and ultimately converting them into more useful articles.

The Production Function

The production function expresses a functional relationship between quantities of inputs and outputs. It shows how and to what extent output changes with variations in inputs during a specified period of time. In the words of Stigler, "The production function is the name given to the relationship between rates of input of productive services and the rate of output of product.

It is the economist's summary of technical knowledge." Basically, the production function is a technological or engineering concept which can be expressed in the form of a table, graph and equation showing the amount of output obtained from

various combinations of inputs used in production, given the state of technology. Algebraically, it may be expressed in the form of an equation as

$$Q = f(L, M, N, K, T) \dots \dots \dots (1)$$

where Q stands for the output of a good per unit of time, L for labour, M for management (or organisation), N for land (or natural resources), K for capital and T for given technology, and refers to the functional relationship.

The Law of Variable Proportions:

If one input is variable and all other inputs are fixed the firm's production function exhibits the law of variable proportions. If the number of units of a variable factor is increased, keeping other factors constant, how output changes is the concern of this law. Suppose land, plant and equipment are the fixed factors, and labour the variable factor.

When the number of labourers is increased successively to have larger output, the proportion between fixed and variable factors is altered and the law of variable proportions sets in. The law states that as the quantity of a variable input is increased by equal doses keeping the quantities of other inputs constant, total product will increase, but after a point at a diminishing rate.

This principle can also be defined thus:

When more and more units of the variable factor are used, holding the quantities of fixed factors constant, a point is reached beyond which the marginal product, then the average and finally the total product will diminish. The law of variable proportions (or the law of non-proportional returns) is also known as the law of diminishing returns. But, as we shall see below, the law of diminishing returns is only one phase of the more comprehensive law of variable proportions.

Its Assumption:

The law of diminishing returns is based on the following assumptions:

- (1) Only one factor is variable while others are held constant.
- (2) All units of the variable factor are homogeneous.
- (3) There is no change in technology.

- (4) It is possible to vary the proportions in which different inputs are combined.
- (5) It assumes a short-run situation, for in the long-run all factors are variable.
- (6) The product is measured in physical units, i.e., in quintals, tonnes, etc. The use of money in measuring the product may show increasing rather than decreasing returns if the price of the product rises, even though the output might have declined.

Its Explanation:

Given these assumptions, let us illustrate the law with the help of Table 1, where on the fixed input land of 4 acres, units of the variable input labour are employed and the resultant output is obtained. The production function is revealed in the first two columns. The average product and marginal product columns are derived from the total product column.

The average product per worker is obtained by dividing column (2) by a corresponding unit in column (1). The marginal product is the addition to total product by employing an extra worker. 3 workers produce 36 units and 4 produce 48 units. Thus the marginal product is 12 i.e., (48-36) units.

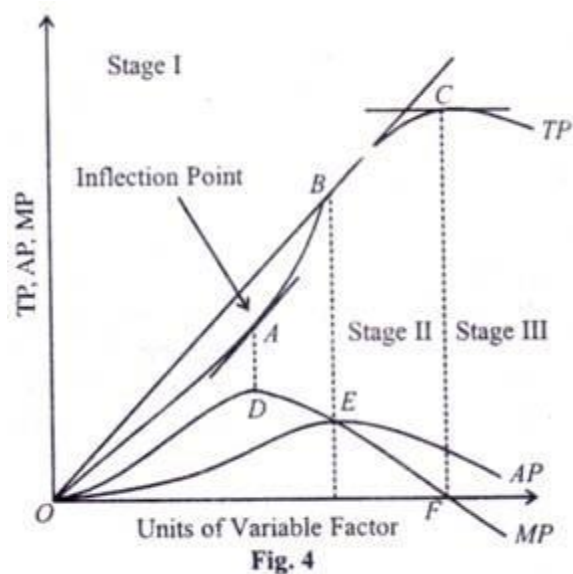
Table. 1: Output of Wheat in Physical Units (Quintals)

(1) <i>No. of Workers</i>	(2) <i>Total Product</i>	(3) <i>Average Product</i>	(4) <i>Marginal Product</i>		
1	8	8	8	}	Stage I
2	20	10	12		
3	36	12	16		
4	48	12	12	}	Stage II
5	55	11	7		
6	60	10	5		
7	60	8.6	0	}	Stage III
8	56	7	-4		

An analysis of the Table shows that the total, average and marginal products increase at first, reach a maximum and then start declining. The total product reaches its maximum when 7 units of labour are used and then it declines. The average product continues to rise till the 4th unit while the marginal product reaches its maximum at the 3rd unit of labour, then they also fall. It should be noted that the point of falling output is not the same for total, average and marginal product.

The marginal product starts declining first, the average product following it and the total product is the last to fall. This observation points out that the tendency to diminishing returns is ultimately found in the three productivity concepts.

The law of variable proportions is presented diagrammatically in Figure 4. The TP curve first rises at an increasing rate up to point A where its slope is the highest. From point A upwards, the total product increases at a diminishing rate till it reaches its highest point C and then it starts falling.



Point A where the tangent touches the TP curve is called the inflection point up to which the total product increases at an increasing rate and from where it starts increasing at a diminishing rate. The marginal product curve (MP) and the average product curve (AP) also rise with TP. The MP curve reaches its maximum point D when the slope of the TP curve is the maximum at point A.

The maximum point on the AP curves is E where it coincides with the MP curve. This point also coincides with point B on TP curve from where the total product starts a gradual rise. When the TP curve reaches its maximum point C the MP curve becomes zero at point F. When TP starts declining, the MP curve becomes negative. It is only when the total product is zero that the average product also becomes zero. The rising, the falling and the negative phases of the total, marginal and average products are in fact the different stages of the law of variable proportions which are discussed below.

Three Stages of Production:

Stage-I: Increasing Returns:

In stage I the average product reaches the maximum and equals the marginal product when 4 workers are employed, as shown in the Table 1. This stage is

portrayed in the figure from the origin to point E where the MP curve reaches its maximum and the AP curve is still rising. In this stage, the TP curve also increases rapidly.

Thus this stage relates to increasing returns. Here land is too much in relation to the workers employed. It is, therefore, profitable for a producer to increase more workers to produce more and more output. It becomes cheaper to produce the additional output. Consequently, it would be foolish to stop producing more in this stage. Thus the producer will always expand through this stage I.

Causes of Increasing Returns:

1. The main reason for increasing returns in the first stage is that in the beginning the fixed factors are larger in quantity than the variable factor. When more units of the variable factor are applied to a fixed factor, the fixed factor is used more intensively and production increases rapidly.
2. In the beginning, the fixed factor cannot be put to the maximum use due to the non-applicability of sufficient units of the variable factor. But when units of the variable factor are applied in sufficient quantities, division of labour and specialization lead to per unit increase in production and the law of increasing returns operates.
3. Another reason for increasing returns is that the fixed factors are indivisible which means that they must be used in a fixed minimum size. When more units of the variable factor are applied on such a fixed factor, production increases more than proportionately. This points towards the law of increasing returns.

Stage-II: Diminishing Returns:

It is the most important stage of production. Stage II starts when at point E where the MP curve intersects the AP curve which is at the maximum. Then both continue to decline with AP above MP and the TP curve begins to increase at a decreasing rate till it reaches point C. At this point the MP curve becomes negative when the TP curve begins to decline, table 1 shows this stage when the workers are increased from 4 to 7 to cultivate the given land.

In figure 1, it lies between BE and CF. Here land is scarce and is used intensively. More and more workers are employed in order to have larger output. Thus the total product increases at a diminishing rate and the average and marginal product decline. This is the only stage in which production is feasible and profitable because

in this stage the marginal productivity of labour, though positive, is diminishing but is non-negative.

Hence it is not correct to say that the law of variable proportions is another name for the law of diminishing returns. In fact, the law of diminishing returns is only one phase of the law of variable proportions.

The law of diminishing returns in this sense has been defined by Prof. Benham thus: “As the proportion of one factor in a combination of factors is increased, after a point, the average and marginal product of that factor will diminish.”

Its Causes: The Law in General Form:

But the law of diminishing returns is not applicable to agriculture alone; rather it is of universal applicability. It is called the law in its general form, which states that if the proportion in which the factors of production are combined, is disturbed, the average and marginal product of that factor will diminish.

The distortion in the combination of factors may be either due to the increase in the proportion of one factor in relation to others or due to the scarcity of one in relation to other factors. In either case, diseconomies of production set in, which raise costs and reduce output.

For instance, if plant is expanded by installing more machines, it may become unwieldy. Entrepreneurial control and supervision become lax, and diminishing returns set in. Or, there may arise scarcity of trained labour or raw material that leads to diminution in output.

In fact, it is the scarcity of one factor in relation to other factors which is the root cause of the law of diminishing returns. The element of scarcity is found in factors because they cannot be substituted for one another.

Mrs Joan Robinson explains it thus : “What the Law of Diminishing Returns really states is that there is a limit to the extent to which one factor of production can be substituted for another, or, in other words, that the elasticity of substitution between factors is not infinite.” Suppose there is scarcity of jute, since no other fibre can be substituted for it perfectly, costs will rise with production, and diminishing returns will operate.

This is because jute is not in perfectly elastic supply to the industry. If the scarce factor is rigidly fixed and it cannot be substituted by any other factor at all,

diminishing returns will at once set in. If in a factory operated by electric power, there being no other substitute for it, frequent power breakdowns occur, as is commonly the case in India, production will fall and costs will rise in proportion as fixed costs will continue to be incurred even if the factory works for less hours than before.

According to Wicksteed, the law of diminishing returns “is as universal as the law of life itself.’ The universal applicability of this law has taken economics to the realm of science.

Stage-III: Negative Marginal Returns:

Production cannot take place in stage III either. For in this stage, total product starts declining and the marginal product becomes negative. The employment of the 8th worker actually causes a decrease in total output from 60 to 56 units and makes the marginal product minus 4. In the figure, this stage starts from the dotted line CF where the MP curve is below the A'-axis. Here the workers are too many in relation to the available land, making it absolutely impossible to cultivate it.

The Best Stage:

In stage I, when production takes place to the left of point E, the fixed factor is excess in relation to the variable factors which cannot be used optimally. To the right of point F, the variable input is used excessively in Stage III. Therefore, no producer will produce in this stage because the marginal production is negative.

Thus the first and third stages are of economic absurdity or economic nonsense. So production will always take place in the second stage in which total output of the firm increases at a diminishing rate and MP and AP are the maximum, then they start decreasing and production is optimum. This is the optimum and best stage of production