1. Details of Module and its structure

Module Detail	
Subject Name	Economics
Course Name	Economics 03 (Class XII, Semester - 1)
Module Name/Title	Law of Variable Proportions – Part 2
Module Id	leec_10302
Pre-requisites	Knowledge of production function
Objectives	After going through this lesson, the learners will be able to understand the following: • Meaning of short run& long run production function. • Use of fixed factors and variable factors in the short run to produce the output. • Working of the Laws of Production in the short run & long run.
Keywords	Fixed factors, Variable factors, Short run production, Long run production, Phases of production, law of returns to factor, law of returns to scale.

2. Development Team

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Table of Contents :

Returns to a factor: It means "change in total physical product when an additional or incremental unit of a variable factor is employed given the fixed factors. Alternatively, 'when only one variable input is increased keeping other inputs constant, the resultant increase in output is called returns to a factor.'

According to the Law of Variable Proportions, **if more and more units of a variable factor are employed with fixed factors, the Total Physical Product (TPP) initially increases at an increasing rate then after point of inflexion it increases at a diminishing rate and finally starts falling.** With reference to Marginal Physical Product (MPP), the law states: **if amounts of a certain variable factor are increased while keeping amount of other factors fixed, MPP first increases then falls, and eventually becomes negative.** Since the proportion in which variable factor and fixed factors are combined gets changed, therefore, this law is also called law of variable proportion. Thus, when more and more units of a variable factor are combined along with fixed factors, total physical product (TPP) passes through three phases, namely, (I) TPP increases at an increasing rate, (II) TPP increasing at diminishing rate. (III) TPP starts declining. In terms of behavior of MPP, 1) Marginal Physical Product (MPP) rises in the first phase and reaches its maximum, 2) MPP falls in the second phase and 3) finally MPP becomes negative. **This law operates in short run when all factors of production cannot be increased (or decreased) simultaneously**

Assumptions of the Law of Variable Proportions

1. It operates under short run where factors are categorized as fixed factor and variable factor.
2. Under this law the different variable factors are combined with the fixed factors

3. The technology given remains unchanged. If technology improves, then marginal product and average products may increase instead of falling, and the law of variable proportions does not apply.
4. At least one input, say, capital must be kept fixed. This law does not apply if all factors are variable.
5. We assume that the factors which are being used for production are imperfect substitutes for each other.

Let us discuss the law of variable proportions with the help of the following schedule and diagram: Consider a field that is being cultivated for growing wheat. The field has an area of 1 acre. The schedule below describes how TPP and MPP change as more labour is hired to cultivate the field.

Table 1: Law of variable proportions

Units of Fixed Factor (Land) in acres	**Units of Variable Input (Labour)**	**TPP**	**MPP**
1	0	-	-
1	1	10	10
1	2	30	20
1	3	45	15
1	4	52	7
1	5	52	0
1	6	44	-8

Diagrammatic Presentation

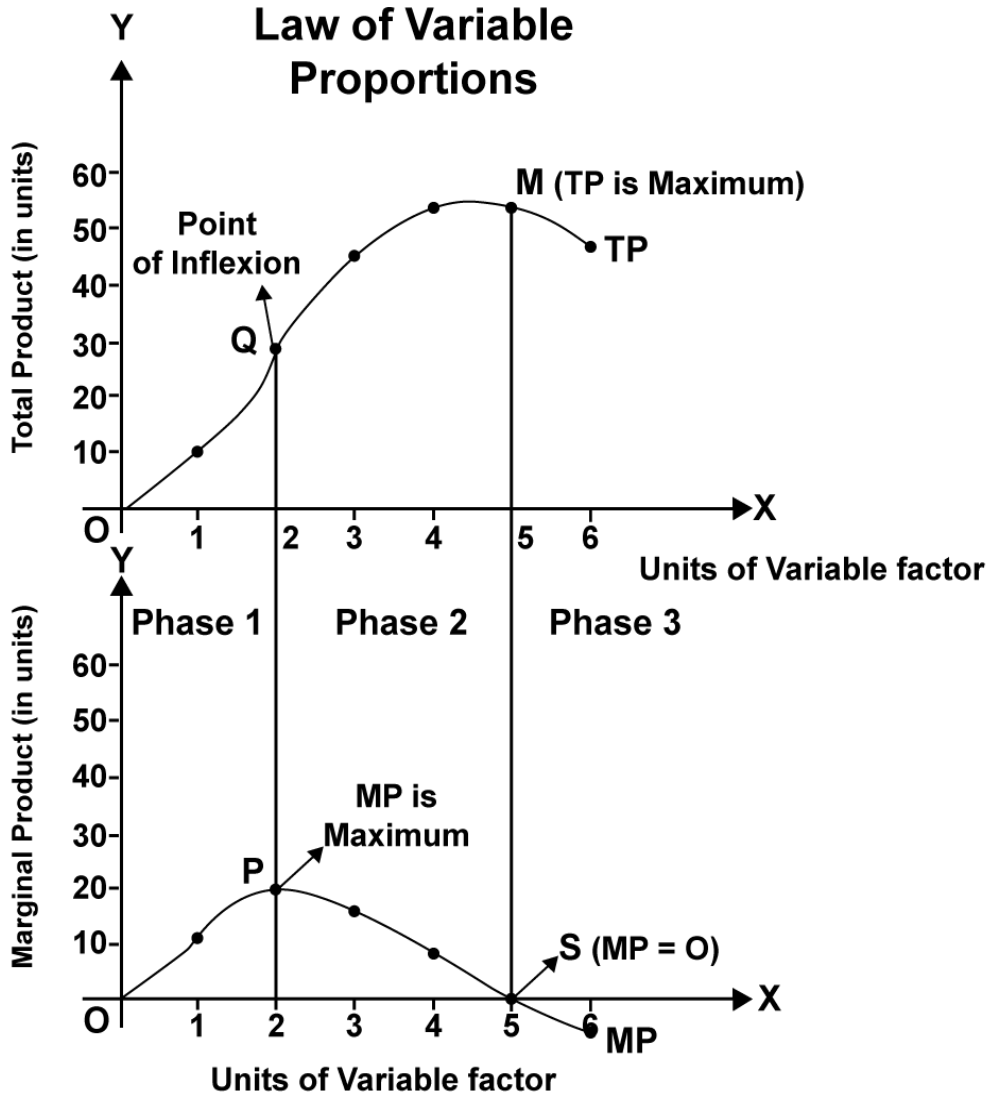

Figure 1: Law of variable proportions

Stages in Law of Variable Proportions

On the basis of changes in TPP and MPP, law of variable proportions is classified into three stages

1st Stage (Increasing Returns to a factor):

When the units of variable input are increased keeping the fixed factors say (land) constant, then fixed inputs are utilised in a better and efficient manner. Due to which efficiency in the production process increases so that **TPP starts increasing at an increasing rate.** This stage continues till the level where

fixed inputs are utilised to their maximum efficiency i.e. the level where MPP becomes maximum. **This level of production is also termed as the Point of Inflexion because TPP changes from increasing at an increasing rate to increasing at a decreasing rate.** In the above diagram we could see that till 2nd units of variable factor employed the producer is able to generate maximum additional production (i.e. marginal product) of 20 units at point 'P' resulting in total production of 30 units at point 'Q'. After P, the marginal product begins to fall. TPP also increases at a decreasing rate. So Q is a point of inflexion.

Reasons for First Stage (Increase Returns to a Factor)

a. ***Better Utilisation of Fixed Inputs***

When units of variable input are increased keeping the other factors constant, then fixed inputs can be utilised in a better and efficient manner due to which efficiency in the production process starts increasing. Looking at the table 1, one can easily observe that two men are more efficient than one man working alone.

b. ***Indivisibility of Inputs***

Indivisibility of inputs can be explained with the help of an example: a teacher is fully competent to teach a class of 30 students with ease and efficiency. If the number of students falls to 15 the efforts of the teacher cannot be reduced to half. The teacher has to put in the same effort, but his 'output' is halved. When the units of variable inputs are increased then the indivisible inputs can be utilised more efficiently due to which efficiency in the production process increases.

c. ***Division of Work / Labour***

When units of variable inputs are increased then the principle of division of work can be applied in the production process which leads to increase in specialisation and hence efficiency in the production process.

2nd Stage (Diminishing Returns to a factor)

The law of diminishing returns to a factor states 'if we keep increasing the employment of an input, with other inputs fixed, eventually a point will be reached after which the resulting additional output (i.e., marginal product of that input) will start falling. When the units of variable input are further increased, then the factor proportion between fixed and variable inputs gets disturbed, due to which

efficiency in the production process starts falling so that **TPP starts increasing at a diminishing rate**. This stage continues till the level where MPP becomes zero and TPP reaches its maximum value. As shown in Figure 1 and Table 1, after second unit of variable factor when more variable factors are employed then the marginal product starts to fall. It touches X-axis at 5^{th} unit. At this point, 'S', the marginal product becomes zero. Notice that the total product has reached its maximum of 52 units at the corresponding point 'M'.

Reasons for Second Stage (Diminishing Returns to a Factor)

a) ***Beyond Optimum Capacity***

If the units of variable inputs are increased to utilise the fixed inputs beyond their maximum or optimum capacity then the factor proportion between fixed and variable inputs gets disturbed due to which efficiency in the production process starts falling. In our example, too many workers on the same field may actually obstruct each other while working, causing output to grow at a diminishing rate.

b) ***Imperfect Substitution***

Variable inputs can be substituted for fixed inputs to a certain limit. If the units of variable input are increased beyond that limit then due to imperfect substitution the efficiency in the production process starts falling. Moreover, substitutes for every fixed input are not available, due to which efficiency also falls.

3^{rd} Stage (Negative Returns to a factor)

When the units of variable inputs are further increased, MPP becomes negative and TPP starts falling. As shown in the Figure 1, after employment of 5^{th} unit of variable factor the marginal production has gone negative and total production has started falling.

Reasons for Third Stage (Negative Returns to a Factor)

a. ***Poor coordination between variable and fixed factor***

When variable factor becomes too excessive in relation to a fixed factor, then they obstruct each other. Too many workers on the same field in our example will only get in each other's way. As a result, total output falls instead of rising and marginal product becomes negative.

b. *Decrease in efficiency of variable factor*

With continuous increase in variable factor, the advantages of specialization and division of labour start diminishing. It results in inefficiencies of variable factor, which is another reason for the negative returns to eventually set in.

Production Function in Long Run (Law of Returns to Scale)

Law of returns to scale operates during long run and represents the effect of changes in scale of production on output produced. Scale or capacity of production is said to be changed when all inputs in the production process are increased in equal proportions keeping their internal ratio constant. When the scale of production is increased in order to increase the production then the production increases either at an increasing rate or at a constant rate or at a diminishing rate.

These three possibilities are termed as increasing returns to scale, constant returns to scale and diminishing returns to scale respectively.

Increasing returns to scale

When the total production increases at a faster rate as compared to the increase in inputs then it is termed as increasing returns to scale. For example if inputs are increased by 100 % and TPP increases by 200 % then it would represent increasing returns to scale. Increasing returns to scale represents the increase in efficiency in the production process due to better division of work and use of specialised machines. Increasing returns to scale can be explained with the help of the following schedule:

Table 2: Increasing returns to scale

UNITS OF		TPP
LABOUR	**CAPITAL**	
2	1	10
4	2	25
6	3	40

Constant returns to scale

When the total production increases at an equal rate as compared to increase in inputs then it is termed as constant returns to scale. For example, if inputs are increased by 100 % and TPP also increases by 100 % then it would represent constant returns to scale.

Constant returns to a scale can be explained with the help of following schedule.:

Table 3: Constant returns to scale

UNITS OF		TPP
LABOUR	CAPITAL	
2	1	10
4	2	20
6	3	30

Diminishing returns to a scale

When the total production increases in a smaller proportion as compared to increase in inputs then it is termed as diminishing returns to a scale. For example if inputs are increased by 100 % and TPP also increases by 80 % then it would represent diminishing returns to scale.

Diminishing returns to a scale can be explained with the help of following schedule and diagram:

Table 4: Diminishing returns to a scale

UNITS OF		TPP
LABOUR	CAPITAL	
2	1	10
4	2	18
6	3	25

Reasons for Increasing Returns to Scale

Increasing Returns to Scale occur generally due to *economies of scale*. It refers to benefits attained due to large scale of production.

Economies of scale can be classified into two categories:

i. **Internal Economies:** It refers to benefits of large scale production which are available to a firm within its own production process. For example, technical Economies in the form of use of

bigger and better machinery and managerial economie, that are achieved through division of labour and specialization.

ii. **External Economies**: It refers to benefits of large scale production which are shared in by all the firms in an industry, when industry as a whole expands. For example, better infrastructural facilities, or the discovery of cheaper sources of a raw material.

Reasons for Decreasing Returns to Scale

Decreasing Returns to Scale occurs generally due to *Diseconomies of Scale*. Diseconomies of scale mean that a firm has **grown so large** that it becomes very difficult to manage it. Diseconomies of scale can be of two types:

i. Internal Diseconomies: It refers to disadvantages of large scale production which a firm has to suffer due to its own production process. For example, difficulty in coordination of management and Technological Diseconomies due to heavy costs of wear and tear.

ii. External Diseconomies: It refers to disadvantages of large scale production which are suffered by all firms in an industry, when industry as a whole expands. For example, shortage of factor and non-factor inputs. congestion, causing transportation delays and higher costs.

Difference between Returns to a Factor and Returns to a Scale

Table 5: Difference between Returns to a Factor and Returns to a Scale

Returns to a Factor	**Returns to Scale**
Operates during short run	Operates during long run
Represents the effect of changes in amount of one variable input on output produced, keeping other factors constant.	Represents the effect of changes in scale of production on output produced

Summary

- Law of variable proportions is based on short run production function.
- It explains that if there is an increment in the quantity of variable factors, keeping fixed factors constant, production takes place in three stages i.e. increasing returns, diminishing returns and negative returns.
    - Reasons for increasing returns – Better utilization of fixed factors, indivisibility of inputs, specialization
    - Reasons for diminishing returns – Use beyond optimum capacity, imperfect substitution
    - Reasons for negative returns – fixity of factors, poor coordination between variable factors and fixed factors.
- Law of returns to scale is based on long run production function.
- It represents the effect of changes in scale of production on output produced. Scale of production is said to be changed when all inputs in the production process are increased in equal proportions keeping their ratio constant.