BLOCK 3
THEORY OF PRODUCTION

BLOCK 3 THEORY OF PRODUCTION

In Block 2 you learnt about the consumer behaviour and theory of demand. Production function and law of supply have equal importance in understanding the basic economic laws. In this block comprising of four units, you will learn about the production function, law of supply, elasticity of supply, and theory of costs and cost curves.

Unit 9 deals with the theory of production, law of variable proportions and the law of diminishing marginal returns.

Unit 10 explains the laws of returns to scale, isoquants and isocosts and economies and diseconomies of scale.

Unit 11 deals with theory of costs and various cost curves.

UNIT 9 THE PRODUCTION FUNCTION-I

Structure

9.0 OBJECTIVES

After studying this unit, you should be able to:

- define the production;
- outline the contents of theory of production;
- distinguish the nature of the production function in the short run and in the long run;
- explain the law of variable proportions;
- identify various stages of the law of variable proportions; and
- explain the law of diminishing marginal returns.

9.1 INTRODUCTION

Production is one of the vital processes of any economy. The meaning of the term 'Production and the relationship between inputs and output should be understood by a student of Economic Theory. In this unit, you will learn the contents and relevance of the theory of production and also the production with one variable input. You will also learn the law of variable proportions and the law of diminishing marginal returns. The concepts of total, average and marginal products will be introduced to explain the law of variable proportions and the law of diminishing returns.

9.2 MEANING OF PRODUCTION

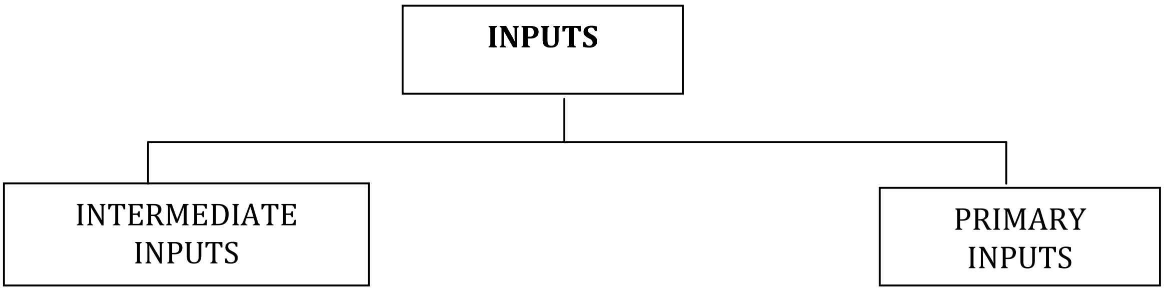
Production can be defined as the creation of different usable goods and services. In other words, production means transforming inputs (labour, machines, raw materials) into output. The process of production does not necessarily involve physical conversion of raw materials into tangible goods. In the process of production an input may be intangible (Service) and an output may be intangible too. Take for example, the production of legal and medical services where both input and output are intangible. Thus production does not only include the creation of material goods but also lawyers, hair-dressers, musicians etc. who are also engaged in productive activity.

Production process may take a variety of forms. A manufacturing unit buying raw materials to create a semi-finished product is engaged in production. Another factory buying semi-finished product to produce finished product is also involved in production activity. The goods produced in this case are material goods. Transporting a commodity from one place to another is the production of service. A coal dealer does virtually nothing more than transporting coal from coal mines to the market place. Similarly, a fisherman only transports fish to the market place. Their activities too are included in production. Storing a commodity for future sale or consumption is also production. Thus, wholesaling, retailing and packaging are all examples of productive activities. In a broad sense, production can be defined as the creation of utility. The word 'utility' has already been introduced to you in Unit 6.

9.3 THE THEORY OF PRODUCTION

The act of production involves the use of inputs to create outputs. The theory of production begins with specific engineering information. If we have a certain amount of labour, land and other inputs such as machines or raw materials, how much output of a particular commodity can we get? To begin with, we can assume a given state of technology and then find out what will be the maximum obtainable amount of output for any given amount of inputs.

The theory of production consists of laws of production or generalizations regarding relations between inputs and outputs. So, it is the general description of the physical relations between inputs and outputs which forms the subject matter of the theory of production. The word inputs imply all that which goes into the production of material goods or services. Some inputs consist of goods and services currently produced by some other producers of the economy. They are referred to as intermediate inputs. Other inputs consist of what is called **Primary inputs** like land, labour, capital and enterprise. **Primary inputs are also referred to as factors of Production.** Take an example of a carpenter who manufactures chairs. The wood, nails, cane and polish used by him are examples of intermediate inputs, while labour put by the carpenter, the place of work, instruments employed by him and the initiative taken by him to manufacture chairs are examples of primary inputs.



9.3.1 Relevance of the Theory of Production

The theory of production has relevance at the micro as well as macro levels. We can list the following four important areas in which the theory of production is relevant.

1) **Price theory:** The theory of production provides a base for the analysis of relation between costs and amounts of output. The prices of inputs influence the costs of production and thus play a part in determining the prices of products. Similarly, the theory of production provides a base for the theory of a firm's demand for factors of production.

2) **Theory of firm:** The theory of production has also a great relevance for the theory of the firm. The theory of the firm is primarily concerned with determining that level of output of a firm which will maximize its total profits. Total profit is the difference between total revenue and total cost. In order to get that level of output at which total profits become maximum, we need to know the concepts of marginal and average costs of production. The changes in marginal and average costs of production as a result of increase in output are determined by the physical between inputs and outputs, besides the prices of factors of production.

3) **Demand for factors of production:** The theory of production explains the forces which determine the marginal productivity of the factors which, in turn, determine demand for them. Demand for a factor of production is one of the important forces determining the price of a factor.

4) **Theory of distribution:** The theory of production is equally relevant to the macro-theory of distribution. It helps us to find out the aggregate distributive shares of the various factors of production. Given the national income of an economy, it is important for us to know the share of wages, profit or rent in national income. These shares can be worked out only when demand for the various factors and their respective prices at which they are hired are known to us.

9.3.2 The Production Function

The tool of analysis which is employed to explain the input-output relationships, implied in the theory of production, is called **Production**

Function. The production function expresses a functional relationship between quantities of inputs and outputs or the production function gives the functional relationship between physical inputs and physical outputs of a producing unit. It specifies the maximum physical quantity of a commodity that can be produced per unit of time with given quantities of inputs and technology. A production function may take the form of a schedule or table, a graphed line or curve, or an algebraic equation. But each of these forms of a production function can be converted into the other forms since they are different ways of expressing this phenomenon. To illustrate the algebraic form of production function, let us assume that a gold mining firm employs only two inputs, capital (K) and labour (L), in its gold production activity. Thus, the general form of its production function can be algebraically expressed as,

$Q = f(K,L)$

Where Q is the quantity of gold production per time unit; K is capital employed per time unit; and Lis labour employed per time unit.

The production function given above implies that Q is the maximum quantity of gold that can be produced with the given volume of capital K and the labour L. Take another example, a firm producing wooden tables, its production function will consist of the maximum number of tables that can be produced from given quantities of various inputs such as wood, varnish, labour time and machine time, etc., that are required to produce tables.

Two things must be noted in respect of the production function.

i) The production function must be considered with reference to a particular period of time. Production function expresses a flow of inputs resulting in a flow of output in a specific period of time.

ii) The production function of a producing unit is determined by the state of technology. When the technology advances, the production function changes with the result that a greater flow of output can be got from the given inputs or smaller quantities of inputs can be used for producing a given flow of output.

9.3.3 Fixed and Variable Inputs

For analysing the process of production, it is important to classify inputs into fixed inputs and variable inputs. A **fixed input**, is defined as one whose quantity cannot be readily changed with changes in output. This situation is given to us because of analytical simplicity and not that any input is ever absolutely fixed. Buildings, machinery and management are some of the examples of inputs that cannot be readily increased or decreased.

A **variable input,** on the other hand, is one whose quantity may be changed simultaneously in response to desired changes in output. The employment of unskilled and semi-skilled labour and the inputs of raw materials are the examples of variable inputs.

For More Clarity!

In microeconomics, the long-run is the conceptual time period in which there are no fixed factors of production as to changing the output level by changing the capital stock or by entering or leaving an industry. The long-run contrasts with the short-run, in which some factors are variable and others are fixed, constraining entry or exist from an industry.

In macroeconomics, the long-run is the period when the general price level, contractual wage rates, and expectations adjust fully to the state of the economy, in contrast to the short-run when these may not fully adjust.

9.3.4 The Short and Long run Period

Corresponding to the distinction between fixed and variable inputs, we have another concept-the short and the long run. The short run is that period of time in which the inputs of some factors of production are fixed while which others are variable. Accordingly, changes in output in the short run are the resultant of changes in the use of variable inputs. For example, if a producing unit wished to expand output in the short run, this normally means using more hours of labour services with the size of plant and equipment remaining unchanged. Similarly, if output in the short run is to be reduced, certain types of workers may be discharged, but we cannot immediately discharge fixed factors like building or machine.

SHORT RUN IS A PERIOD OF TIME IN WHICH AT LEAST ONE INPUT IS FIXED, ITS QUANTITY CANNOT BE INCREASED

The long run is defined as that period of time in which all inputs are taken to be variable. In the long run, output changes can be achieved in the manner most advantageous to the producer. For example, in the short run, a producer may be able to expand output only by operating the existing plant for more hours per day. For this the producer may have to pay overtime rates to workers. In the long run, it may be more economical to install additional productive capacity and return to the normal working day. This distinction between the short run and the long run is of great importance in the theory of production as it gives us the short-run production function and the long run production function respectively.

For example, in the short run, a producer may be able to expand output only by operating the existing plant for more hours per day. For this, the producer may have to pay overtime rates to workers. In the long run, it may be more economical to install additional productive capacity and return to the normal working day.

LONG RUN IS A PERIOD OF TIME IN WHICH QUANTITY USED OF ALL FACTOR INPUTS CAN BE INCREASED.

Check Your Progress A

1) What do you mean by production of tangibles and intangibles?

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2) What are primary inputs?

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3) What is a production function?

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4) Classify the following into fixed and variable inputs.

	Input	Classification		
i)	Raw material	--	--	--
ii)	Skilled labour	--	--	--
iii)	Factory office	--	--	--
iv)	Management	--	--	--
v)	Machines			
vi)	Supervisory staff	--	--	--
vii)	Unskilled labour	--	--	--
viii)	Tools	--	--	--

5) State whether the following statements are **True** or **False.**

   i) Production consists of tangible goods alone.

   ii) Production of semi-finished products is production.

   iii) Production consists of only those goods and services which are exchanged in the market.

   iv) A firm require only land, labour capital to produce a flow of goods.

   v) The distinction between fixed and variable inputs is relevant only in the long run.

   vi) Production undertaken by a firm over one week is termed as short run.

   vii) Production undertaken by a firm over one month is termed as long run.

   viii) The proportion in which inputs are employed by a firm remain fixed in the short run.

9.4 THE LAW OF VARIABLE PROPORTIONS

Fixed proportions production implies that there is one ratio of inputs that can be used to produce a level of output. If output is increased, all inputs must be increased such that the fixed input ratio is maintained.

When a fixed amount of one input or more than one input is combined with a variable amount of a variable input or inputs, we get a situation of variable proportions. Take for example a farmer who produces say 200 Kg of wheat on a given size of land say one hectare by employing 2 labourers who plough the land with the help of a tractor. If size of land continues to be one hectare and one tractor continues to be employed but this time not 2 labourers but say 3 labourers are employed, then total production may go up to say 300 Kg of wheat. What has happened is that in the first situation the ratio of labourers (variable input) to land and tractors (fixed inputs) is 2:1 and the output of wheat 200 Kg. In the second case ratio of labourers (variable input) to land and tractor (fixed inputs) has increased to 3:1 and the output of wheat has increased to 300 Kg. Thus, as variable inputs are combined with fixed inputs a certain pattern is observed in total production which is referred to as the **Law of variable proportions**. The basic concern of this law is to explain how output change, if the number of units of a variable input is increased, keeping other inputs constant or fixed.

9.4.1 Fixed and Variable Proportions

Fixed production implies that there is one ratio of inputs that can be used to produce a level of output. If output is increased, all inputs must be increased such that the fixed input ratio is maintained. For example, if four labourers and one machine produce 100 units of a commodity and if 200 units are to be produced, then for fixed proportions production labourer machine ratio continues to be 4:1. At first glance fixed proportions production might seem the usual condition but in reality examples of such proportions are hard to come by Production under conditions of variable proportions is typical of both the short and long run. The proportions are certainly variable in the long run. In the short run, there may be some cases in which output is subject to fixed proportions like one person and shovel produce a ditch and adding one more shovel but keeping one person will not add to total output. Even in the short run there are some cases of variable proportions production.

THINK AND DO
BELOW ARE GIVEN TWO TABLES, A AND B WHICH OF THESE REPRESENTS VARIABLE PROPORTIONS

TABLE A			TABLE B		
X-INPUT		Y-INPUT	X-INPUT		Y-INPUT
2	+	1	2	+	1
2	+	2	4	+	2
2	+	3	6	+	3

As factor proportions change with increase in the quantity of factor-inputs, how does the quantity of total output respond? The answer is provided by the Law of variable proportions.

The basic concern of the Law of Variable Proportions is to explain how output changes if the number of units of a variable input is increased, keeping other inputs constant or fixed.

9.4.2 Statement of the Law of Variable Proportions

The law of variable proportions sets in when the proportion between fixed and variable inputs is altered. According to this law **as the quantity of a variable input is increased by an equal amount, keeping the quantities of other inputs constant, total output will increase, but after a point, at a diminishing rate.** This law can also be put differently. 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. For understanding the law of variable proportions, first you should clearly understand the concepts of total, average and marginal products.

9.4.3 Total, Average and Marginal Product

The student should be absolutely clear about the concepts of total, average and marginal products before analysing the law of variable proportions. Let us take an example of a farmer cultivating four hectares of land with a tractor and varying the number of workers and let us analyze the level of production of wheat in physical units say in tons.

Table 9.1: Output of Wheat in tons on Four Hectares of Land

Number of Labourers	Total Output (tons)
1	10
2	24
3	39
4	52
5	61
6	66
7	66
8	64

In Table 9.1 you can see how the total output of wheat changes by employing different number of labourers working with same size of land namely four hectares. As the number of labourers keep increasing, total production goes on rising until it becomes maximum of 66 tons when six labourers are employed and the employment of 7th labourer does not add to total production. If we insist on employing eight labourers total production falls to 64 tons.

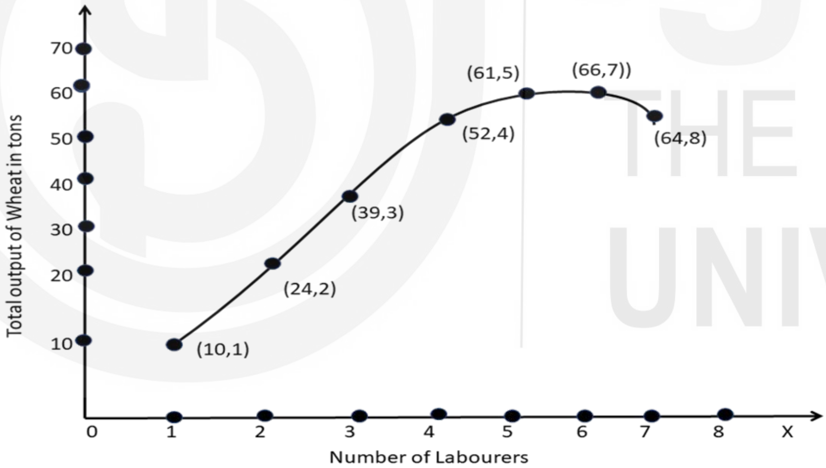

Figure 9.1 : Graphical Representation of wheat in tons on Four Hectares of Land

The information given in Table 9.1 has been represented in Figure 9.1 where on x axis we represent the number of labourers and on y-axis total output of wheat in tons is represented. The level of output produced by a different number of labourers is represented by a curve. The digits on the line represent level of output achieved by different number of labourers. For instance, (10,1) means that 10 tons of output is produced by 1 labourer and similarly (24,2) means that 24 tons of output is produced by 2 labourers and so on.

From Table 9.1 we can get information along average product and marginal product as shown in Table 9.2 and represented in Figure 9.2.

Table : 9.2 : Total, Average and Marginal Product of Wheat in tons on Four Hectares of Land

Number of Labourers (1)	Land Labour Ratio (2)	Total Output (3)	Average Product of Labour (4)	Marginal Product of Labour (5)
1	4.00	10.00	10.00	--
2	2.00	24.00	12.00	14.00
3	1.33	39.00	13.00	15.00
4	1.00	52.00	13.00	13.00
5	0.80	61.00	12.20	9.00
6	0.67	66.00	11.00	5.00
7	0.57	66.00	9.40	0.00
8	0.50	64.00	8.00	-2.00

Table 9.2 gives the number of labourers employed, land, labour ratio, total output, average product and marginal product. Column 2 gives us land-labour ratio. Land is fixed at 4 hectares of land by labourers to get land-labour ratios at different level of labourers employed. We get average product by dividing Column 3 by Column 1. We get marginal product by subtracting total output produced by say *x* labourers from total output by *x*+ 1 labourers where *x* can be 1,2,3........... 7.

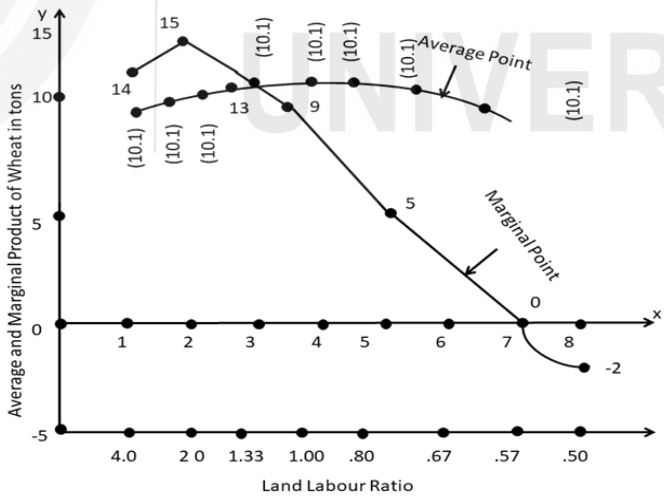

Figure 9.2 : Graphical Representation of Average and Marginal Product of wheat

The average and marginal product figures of Table 9.2 along with land-labour ratios and number of labourers employed are represented in Figure 9.2. The X-axis measures the number of labourers employed, Y-axis measures average and marginal product of wheat in tons. Below the X-axis, we have represented the land-labour ratios corresponding to each number of labourers employed. The figures corresponding to number of labourers employed and average product are shown by the curve marked average product, and marginal product figures are shown by the curve marked marginal product. We can easily notice that marginal product rises in the beginning, becomes maximum (i.e. equal to 15) when 3 labourers are employed, then continues to fall until it becomes zero when 7 labourers are employed and finally becomes negatives (equal to -2) when 8 labourers are employed. Average product rises until 3 labourers are employed, becomes equal to marginal product (13) when 4 labourers are employed and after that it continues to fall. It is also worth noting that land-labour ratio continues to fall as we move away from the origin.

For More Clarity!

The **average physical product** is the total production divided by the number of units of variable input employed. It is the output of each unit of input. If there are 10 employees working on a production process that manufactures 50 units per day, then the average production of variable labour input is 5 units per day.

The **marginal physical product** of a variable input is the change in total output due to one unit change in the variable input (called the **discrete marginal product**) or alternatively the rate of change in total output due to an infinitesimally small change in the variable input (called the **continuous marginal product**).

BRAIN TEASER

1. Answer the following questions:

i) When marginal product increases, what happens to average product?

ii) Does average product begin to fall as soon as marginal product does? Which occurs first, the point diminishing marginal or average returns?

iii) When average product is at its maximum, is marginal product less than, equal to, or greater than average product?

iv) Does total product increase at a decreasing rate

a) when average product is rising?

b) when marginal product is rising?

c) when average product beings to fall?

d) when marginal product passes its maximum value?

v) When average product equals zero, what is total product?

Answers:

i) Average product also increases but is less than marginal product.

ii) No, The point of diminishing marginal returns occurs first.

iii) When average product is at its maximum, average product and marginal product are equal.

iv)

a) Initially, total product increases at an increasing rate but after marginal product being to fall, total product increases at a diminishing rate.

b) Total product increase at an increasing rate.

c) Total product increase at a decreasing rate till the marginal product is positive and is more than zero.

d) After the marginal product has passed its maximum value and begins to decline, total product increases at a decreasing rate.

v) Total product is also zero.

9.4.4 Three Stages of Production

From the above, we can easily identify three stages of production. Look at Figure 9.3 where these three stages of production have been shown.

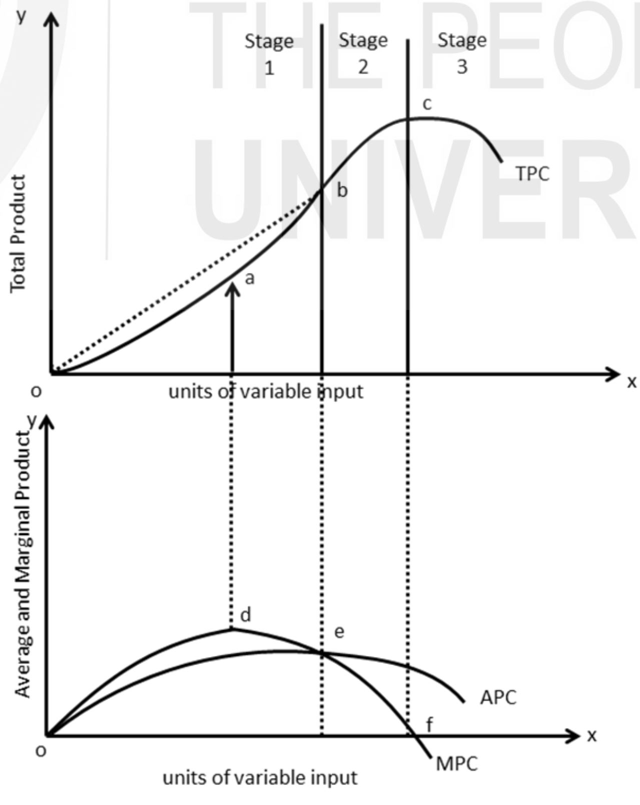

Figure 9.3 : Graphical Representation of Total, Average and Marginal Product

Let us start with Total Product curve up to point 'a' on the curve, total product rises at a rising rate as more of variable input is employed. From point 'a' to point 'b' total product continues to rise but at a falling rate and the rate of increase of total output progressively falls from point 'b' to point 'c'. At 'c' total output becomes maximum and begins to fall beyond that. Marginal product at first increases and reaches a maximum at point d' which is also the point of diminishing marginal physical returns and falls thereafter. After a stage it becomes negative. Average product rises until it reaches its maximum at point 'e' where marginal and average products are equal. It subsequently declines and will become zero when total product becomes zero.

On the basis of above discussion three stages of production can be described as follows:

i) **Stage 1** corresponds to the use of the variable input to the left of point 2 where average product achieves its maximum.

ii) **Stage 2** corresponds to the use of the variable input between point 'e' and point ‘f’ where the marginal product of the variable input becomes zero.

iii) **The Stage 3** corresponds to the use of variable input to the right of point 'e' where the marginal product of the variable input negative.

The rising, the falling and the negative phases of the total, marginal and average products are the different stages of the Law of Variable Proportions. The total output first rises at an increasing rate and then reaches the highest point at a decreasing rate and starts falling thereafter.

Stage	Total Product	Marginal Product	Average Product
Stage I	Initially increases at an increasing rate, and subsequently at a diminishing rate.	Increases initially, reaches the maximum and then falls	Increases throughout the stage and reaches the maximum.
Stage II	Continues to rise at a *diminishing rate*, and eventually reaches the maximum	Continues to fall and eventually becomes zero	Begins to fall.
Stage III	Begins to fall	Becomes negative	Continues to fall, but is always positive.

9.5 THE LAW OF DIMINISHING MARGINALRETURNS

In Figure 9.3 you have seen that up to point ‘a' we have a situation where total product, average product and marginal product are rising as more units of variable input are employed. It can be put differently by saying that total product is rising at a rising rate up to point ‘a'. Beyond 'a' and up to point 'c' we find marginal product is falling until it becomes zero at point ‘f’. Average product starts falling beyond point 'e' (where average product is equal to marginal product). But from point 'a' to point 'c', since marginal product falls, total product rises but at a falling rate. This situation of the total product rising at a falling rate or the marginal product falling is referred to as the **application of the law of diminishing marginal returns**. We can also say that the law of diminishing marginal returns is a special case of the law of variable proportions. Similarly, up to point ‘a' we find that total product rises at rising rate or marginal product rises. This is referred to as the **law of increasing marginal returns.** To begin with, each industry operates in such a manner that it is able to best utilize the fixed inputs and thus keeps enjoying the advantage of total product rising at a rising rate or marginal product rising. Beyond a point when variable to fixed input proportion is optimum, it is no longer possible to enjoy increasing marginal returns. In fact as more of variable input is added to fixed inputs, total product rises but only at falling rate implying thereby the operation of the law of diminishing marginal returns. The application of **the law of diminishing marginal returns** is subject to a number of assumptions, which are as follows:

1) It is possible to vary the proportions in which the various inputs are combined.
2) Only one input is variable while others are held constant.
3) All units of a variable input are homogeneous.
4) There is no change in technology. If the technique of production undergoes: change, the total product curve will be shifted upwards.
5) Input prices remain unchanged.

With a few assumptions the law of diminishing marginal returns is applicable to a wide range of production activities. In some productive activities, it may operate quickly and in some, its operation may be delayed. This law has been found to be applicable in agricultural production more quickly than in industrial production, because in the former, a natural factor (i.e., land), plays a predominant role, while in the latter man-made factors plays the major role.

The law also applies to river-fisheries where the application of additional doses of labour does not bring about a proportionate increase in the amount of fish caught. Similarly, in the case of quarries (mines) and brick fields the continued application of labour will result in a diminishing marginal return. This happens because cost will rise in proportion to the production as mining operations are extended deep into the mines. The law applies to buildings where the building of a skyscraper requires additional expenses for providing artificial light and ventilation to the lower storey’s and lifts to reduce the inconvenience of going to the higher floors. This means increase in costs and diminishing marginal returns. It would not be correct to say that this law applies to agriculture alone; it operates in all types of industries. Its application can be postponed by technological advancements but eventually a stage is reached when the operation of the law of diminishing marginal returns will set in.

Check Your Progress B

1) Describe the law of variable proportions.

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2) Define Total, Average and Marginal Products

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3) State whether the following statements are **True** or **False.**

   i) Fixed inputs remain fixed in the long run.

   ii) In the short run we normally have fixed factor proportions.

   iii) Stage 1 of production corresponds to law of diminishing marginal returns.

   iv) When average product equals zero, total product is maximum.

   v) When average product is maximum, marginal product is greater than average product.

   vi) The point of diminishing marginal returns occurs earlier than average returns.

   vii) The law of diminishing marginal returns applies to agriculture alone.

   viii) The law of variable proportions is a special case of the law of diminishing marginal returns.

4) Fill in the blanks.

Units of Variable Input	Total Product	Average Product	Marginal Product
9	1,146	-	-
10	1,234	-	-
11	1,314	-	-
12	1,384	-	-
13	1,444	-	-
14	1,494	-	-

9.6 LET US SUM UP

Production is the creation of different usable goods and services. The theory ofproduction deals with the transformation of inputs into outputs. This theory has its relevance in price theory, theory of the firm, theory for the demand for factors ofproduction and also in the theory of factor shares at the macro level. The production function is the functional relationship between quantities of inputs and outputs. Q = (K,L) is the general form of the production function.

Inputs can be fixed and variable. In the short run some inputs are fixed and others can be regarded as variable. In the long run, all inputs are variable. The law of variable proportions is the operation of the theory of production in the short run. We assume that conditions of variable proportions as opposed to fixed proportions exist for the law to apply.

The law of variable proportions states: As the quantity of a variable input is increased by an equal amount, keeping the quantities of other inputs constant, total output will increase, but after a point, at a diminishing rate. Total product rises initially at a rising rate, then at a falling rate as more of a variable input is combined with fixed inputs. The marginal product rises, becomes maximum and then begins to fall until it becomes zero as more of a variable input is used.

There are three stages of production. Stage 1 corresponds to use of the variable input to the left of a point where average product becomes maximum. Stage 2 is a situation where the marginal product of the variable input becomes zero and Stage 3 corresponds to the point where marginal product of the variable input becomes negative. The law of diminishing marginal returns is a special case of the law of variable proportions. The law of diminishing marginal returns operates beyond a point where marginal physical product becomes the maximum with the use of a variable input. This law is based on two important assumptions namely, (1) technology remains unchanged and (2) all units of a variable input are homogeneous.

This law has wide applications ranging from agriculture, fisheries and industry. It has more or less a universal application in all production activities. Its application can be postponed by technology advancements but eventually it does start applying.

9.7 KEY WORDS

Average Product: Total physical product divided by units of variable inputs.

Fixed Inputs: Those inputs whose quantity does not change with immediate change in output in which they enter as inputs.

Homogeneous Unit: A unit which is uniform in relation to other unit of a factor or input.

Inputs: Whatever goes into the production of goods and services.

Intermediate Inputs: Inputs produced by other domestic producers of an economy or coming from other countries.

Long Run: That period of time in which all inputs are taken to be variable.

Marginal Product: The addition to total physical product by employing one extra unit of a variable input.

Macro Theory: Theory explaining aggregate variables like national income or employment or factor shares in national income, etc.

Production: The creation of different usable goods and services.

Production Function: A functional relationship between quantities of inputs and outputs.

Primary Inputs: Inputs provided by the services rendered by land, labour, capital and enterprises.

Semi-Finished product: A product between the stage of raw material and finished product.

Short Run: That period of time in which some inputs of factors of production are fixed and others can be regarded as variable.

Technology: Manner in which various inputs are combined to get a level of output.

Variable Inputs: Those inputs whose quantity changes with simultaneous change in output in which they enter as inputs.

9.8 ANSWERS TO CHECK YOUR PROGRESS

Check your progress A

4 (i) Variable (ii) Variable (iii) Fixed (iv) Fixed (v) Fixed (vi) Fixed (vii) Variable(viii) Variable/ Fixed.

5 (i) False (ii) True (iii) False (iv) False (v) False (vi) False (vii) False (viii) False

Check your progress B

3 (i) False (ii) False (iii) False (iv) True (v) False (vi) True (vii) False,(viii) False

Inputs	Average Product	Marginal Product
9	127.3	-
10	123.4	88
11	119.4	80
12	115.3	70
13	111.3	60
14	106.7	50

9.9 TERMINAL QUESTIONS

1) Define Production. What is the theory of Production?
2) Distinguish between primary and intermediate inputs.
3) Explain the relevance of theory of production in various fields.
4) Explain the concept of the production function.
5) Distinguish between fixed and variable inputs. What is the importance of this distinction in the theory of production?
6) Explain the law of variable proportions with the help of total, average and marginal product.
7) Explain the law of diminishing marginal returns. Also state its assumptions. Does it apply to agriculture alone?

Note: These questions will help you to understand the unit better. Try to write answers for them. But do not submit your answers to the University for assessment. These are for your practice only.

UNIT 10 THE PRODUCTION FUNCTION-II

Structures

10.0 OBJECTIVES

After studying this unit, you should be able to:

- explain the laws of returns to scale;
- describe what is production function;
- describe an Isoquant and Isocost curve;
- enumerate properties of an isoquants;
- identify least cost combination of factors;
- distinguish between the nature of economies of scale and diseconomies of scale
- outline the relation between isoquants and returns to scale.

10.1 INTRODUCTION

In the previous unit, you have learnt that a change in factor proportions brings about a change in total output. Factor proportions are altered by keeping the quantity of one or some factors fixed and varying the quantity of the other. In this unit, you will learn the nature of laws of returns to scale where all the factors are increased in a given proportion. The laws of returns to scale will be explained with the help of Production Function, numerical examples and isoquants. We shall also discuss how a producing firm decides about the cast cost combination of factors. Economies of Scale will be introduced to explain the existence of increasing Returns to Scale. The concept of Diseconomies of Scale will also be introduced.

Table10.1: Differences between the Short-run and Long-run Production Functions

Short-run Production Function	Long-run Production Function
1. Short-run implies that planning horizon during which a firm cannot change some of the fixed factors of production (such as costly machines) to change its level of output	Long-run denotes that planning horizon during which a firm can change all the factors of production to change its level of output
2. The short-run production function shows the interdependence between output and the inputs consisting of both fixed and variable factors.	The long-run production function shows the interdependence between output and the inputs, all of which are variable in nature.
3. The short-run production function can be expressed as: X = f (K, L), where X = output, K = Fixed factor (say, capital) and L = Variable factor (say, labour)	The long-run production function can be expressed as: X = f (K, L), where both K and L are variable factors. Thus, the number of variable factors in the production function is relatively more in case of long-run production function

10.2 THE LAWS OF RETURNS TO SCALE

The long run production theory is concerned with input-output relationship under the condition that all inputs are variable factors. The long run production theory analyses the changes in output when all factors or inputs, in a particular production function, are increased together.

In other words, the behaviour of output in response to the changes in the scale is studied in the long run production theory. An increase in the scale means that all inputs or factors are increased in the same proportion.

Increase in the scale occurs when all factors or inputs are increased keeping factor proportions unchanged.

The long run production theory which is another name to the laws of returns to scale is thus an attempt to study the changes in output as a consequence of changes in the scale. More precisely, the laws of returns to scale explain how a simultaneous and proportionate increase in all the inputs affects the total output at its various levels.

10.2.1 Statement of the Laws of Returns to Scale

When a producing unit increases all its inputs proportionately, technically, there are three possibilities, i.e., the total output may increase proportionately, more than proportionately, or less than proportionately. Accordingly, we have three laws of returns to scale which are as follows:

1) **Constant returns to scale:** If a producing unit increases all its inputs in a given quantity (say X %) and the total output also increases in the same proportion (X %). then it implies the existence of **Constant Returns to Scale.** To take an example, suppose all inputs are doubles, and then if total output is also doubled, this would have been possible only when there exist constant returns to scale. In short, if increase in the total output is proportional to the increase in inputs, it means a situation of constant returns to scale exists.

2) **Increasing returns to scale:** If a producing unit increases its inputs say by X% and the total output increases by more than X%, then it implies the existence of **Increasing Returns to Scale.** To take an example, suppose all inputs are doubled, and then if total output is more than doubled, this would have been possible only when there exist increasing returns to scale. In short, if increase in the total output is greater than the proportional increase in the inputs, it means that a situation of increasing returns to scale exists.

3) **Diminishing returns to scale:** If a producing unit increases all its inputs say by X% and the total output increases by less than X%, then it implies the existence of Diminishing Returns to scale. To take an example, suppose all inputs are doubled, and then if total output is less than doubled, this would have been possible only when there exists diminishing returns to scale. In short, **if increase in output is less than proportionate to the increase in inputs, it means that a situation of diminishing returns to scale exists.**

10.2.2 Production Function and Returns to Scale

The laws of Returns to Scale can be explained more precisely through the Production Function which has already been introduced in Unit 8. Let us take a production model involving only two variable inputs, capital (K) and labour

(L) and one commodity X. The Production Function can then be expressed as:

$Q_x = f(K,L)$

Where Q_x denotes the quantity of commodity X, K stands for capital and L for labour employed. Let us further assume that both the inputs K and L are increased in the same proportion say p. It is quite likely that if all the inputs are increased in proportion p, the total output may not increase in p proportion. Suppose we represent the proportion by which output rises by h then the Production Function may be expressed as

$hQ_x = f(pK, PL)$

where, h denotes the h-time increase is Q_x as a result of p-time increase in inputs, K and L. The proportion h may be equal to, greater than, or less than p, accordingly, it brings out the three laws of returns to scales.

i) If h= p, the production function reveals constant returns to scale.

ii) If h > p, the production function reveals increasing returns to scale.

iii) If h < p, the production function reveals diminishing returns to scale.

Let us take a numerical example to explain three laws of returns to scale. Suppose a producing unit employs 5 labourers and one machine which gives it an output of say 100 units of a commodity. Assume that labour and machine are both variable inputs such that we are considering a situation of the long run.

Now, suppose the producing unit doubles the labour and capital employing 10 labourers and two machines and if the total output increases to 200 units, it means we have the existence of **Constant Returns to Scale** since 100% increase in labour and capital leads to 100% increase in output.

Further suppose that the employment of 10 labourers and two machines raises total output to 300 units, then 100% increase in labour and capital leads to 200% increase in output. This is, accordingly, termed as **Increasing Returns to Scale**.

Similarly, suppose that the employment of 10 labourers and two machines raises total output to 150 units, and then 100% increase in labour and capital lead to 50% increase in output. This is a situation of **Diminishing Returns to Scale.**

10.3 ISOQUANTS AND ISOCOSTS

There are various ways in which production function can be represented. It can be represented by tables, mathematical equations, and total, average and marginal product curves. When two factors or inputs are to be explicitly shown, production function can be represented by equal product curves or Isoquants. In order to get an optimal factor combination of a producing unit, we make use of Isoquants and Isocost Lines.

10.3.1 Isoquants

An Isoquant is a curve on which the various combinations of two factors say labour and capital give us the same level of output per unit of time. The table 10.1 below shows a hypothetical Isoquant schedule of a firm producing 100 units of a commodity.

Table 10.1 Tabular Representation of Isoquant

Combination	Labour input	Capital input	Total output (in units)
A	5	9	100
B	10	6	100
C	15	4	100
D	20	3	100

The information given in Table 10.1 has been represented on Figure 10.1 where labour units are measured along the x-axis and capital units on the y-axis. Point ‘a' represents the combination of 5 units of labour and 9 units of capital to give an output of 100 units. Similarly, point b represents 10 units of labour and 6 units of capital to get an output of 100 units. Likewise, points 'c' and 'd' from the table are shown in the diagram. If we join points a, b, c and d, we get a curve known as an Isoquant.

A number of Isoquants representing different amounts of output are known as an Isoquant map. Look at Figure 10.1 where three Isoquants representing output of 100units, 200 units and 300 units respectively are shown which can be produced with altogether different combination of the two factors labour and capital.

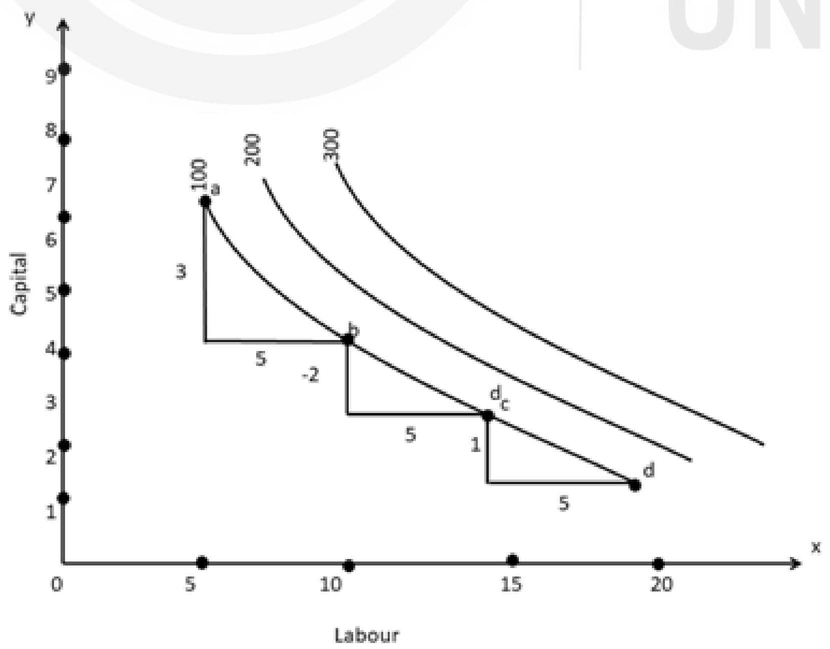

Figure 10.1: Graphical Representation of Isoquant

10.3.2 Marginal Rate of Technical Substitution

It may be noted that movement along an Isoquant indicates substitution of one factor for another. For example, movement from point a to b means that 5 units of labour is substituted for 3 units of capital or putting it differently it means that 3 units of capital can produce as much as 5 units of labour. The rate at which one factor can substitute another is called **marginal rate of technical substitution.**

In general terms, marginal rate of technical substitution of labour for capital may be defined as the amount of capital which can be replaced by one unit of labour, the level of output remaining the same.

It is worth noting that marginal rate of technical substitution of labour for capital keeps falling as we move along an Isoquant from point a to d.' Take for example, by moving from a to b we find that 5 units of labour are substituted for 3 units of capital, 5 units of labour are substituted for 2 units of capital as we move from b' to c and finally 5 units of labour are substituted for 1 unit of capital as we move from c to d. The rate, at which the marginal rate of technical substitution diminishes, as we move along an Isoquant from left to right, is a measure of the extent to which the two factors can be substituted for each other. The smaller the rate at which the marginal rate of technical substitution diminishes, the greater the substitutability between the two factors.

In the extreme case, if the marginal rate of substitution between any two factors remains constant, the two factors are perfect substitutes of each other and accordingly the Isoquant will be straight line falling from left to right. In reality marginal rate of technical substitution diminishes as more and more of capital is substituted for labour and, therefore, an isoquant is convex to the origin as shown in Figure 10.1.

The marginal rate of technical substitution of labour for capital can also be expressed as the ratio of the marginal physical product (already introduced to you in unit 9) of labour to the marginal physical product of capital. This result can be derived as follows:

Reduction in capital X marginal physical product of capital = increase in labour X marginal physical product of labour

orΔK.MPK = ΔL: MPL

Or

$\frac{\Delta K}{\Delta L} = \frac{MPL}{MPK}$ but $\frac{\Delta K}{\Delta L}$ is the Marginal Rate of Technical

Substitution of Labour for Capital expressed as$\frac{MRTS}{LK}$

Therefore, $\frac{\text{MRTS}}{\text{LK}} = \frac{\text{MPL}}{\text{MPK}}$

In simple terms, the above relationship implies that as we move along an isoquant from point a to point d more labour is employed and marginal physical product of labour falls and the gain in total output is the result of change in labour and marginal physical product of labour. Further, as more labour is employed, less capital is employed but marginal physical product of capital rises and the gain in total output is the result of change in capital and marginal physical product of capital. Since on an isoquant, total output, by definition, remains unchanged, we equate the loss in output with gain in output and thus, as shown above,

MRTS the result $\frac{\text{MRTS}}{\text{LK}} = \frac{\text{MPL}}{\text{MPK}}$ is derived so the principle of diminishing

MPL is derived.

So the principle of diminishing marginal rate of technical substitution is merely an extension of the law of diminishing marginal returns to the relation between the marginal physical productiveness of labour and capital. Further, we are also able to realise why less and less of capital is required to be substituted by an additional unit of labour so as to maintain the same level of total output.

10.3.3 Properties of an Isoquant

You have been already introduced to the concept of an indifference curve in unit 8; the properties of an isoquant are the same as that of an indifference curve. The following are the important properties of an isoquant.

1) **An isoquant slopes downwards from left to right or it has a negative slope.** This is so because when the quantity of one input is increased, the quantity of the other input must be reduced so as to keep total output constant.

2) **Two isoquants cannot intersect each other**. If they do intersect it will mean that at the interaction point a given combination of two inputs will give two different levels of output. But this is quite absurd. How can the same input combination produce two different levels of output, techniques of production remaining unchanged.

3) **An isoquant is convex to the origin.** The convexity of an isoquant is due to the diminishing marginal rate of technical substitution. The convexity of an isoquant also implies the operation of the law of diminishing marginal returns. The diminishing marginal rate of technical substitution occurs, because of the fact that different factors are imperfect substitutes of each other in the production of a commodity. An isoquant is normally convex to the origin.

EXCEPTIONAL ISOQUANTS

We have assumed so far that the two factors–inputs are perfect substitutes for each other. We can also look at least two other possibilities.

1) Two factors are perfect substitutes for each other.

2) Two factors are perfect complements for each other.

1) FACTOR-INPUTS ARE PERFECT SUBSTITUTES

When two factors are perfect substitutes of each other, then each of them can be used equally well in place of the other, Therefore, the marginal rate of technical substitution between two perfect substitute factors remain constant. The shape of an isoquant in such a case is straight line. By looking at Figure 10.2 we can realise that for employing 5 extra units of labour, 2.5 units of capital are to be reduced as we move from point a to b or from point b to c.

In case two factors are perfect substitutes the shape of the isoquant will be as shown in Figure 10.2.

Figure 10.2 : Factor Inputs are perfect substitutes

2) TWO FACTORS ARE PERFECT COMPLEMENTS

Another exception to the shape of an isoquant occurs when factors are perfect complements. This case is shown in Figure 10.3. The isoquant is shown to be a right angled one. Perfect complementary factors are those which are jointly used for the production in a fixed proportion. Thus, 5 units of labour and 2 units of capital give us the level of output Q_1. An increase in one factor say capital without the required proportional increase in labour will not give additional output whatsoever.

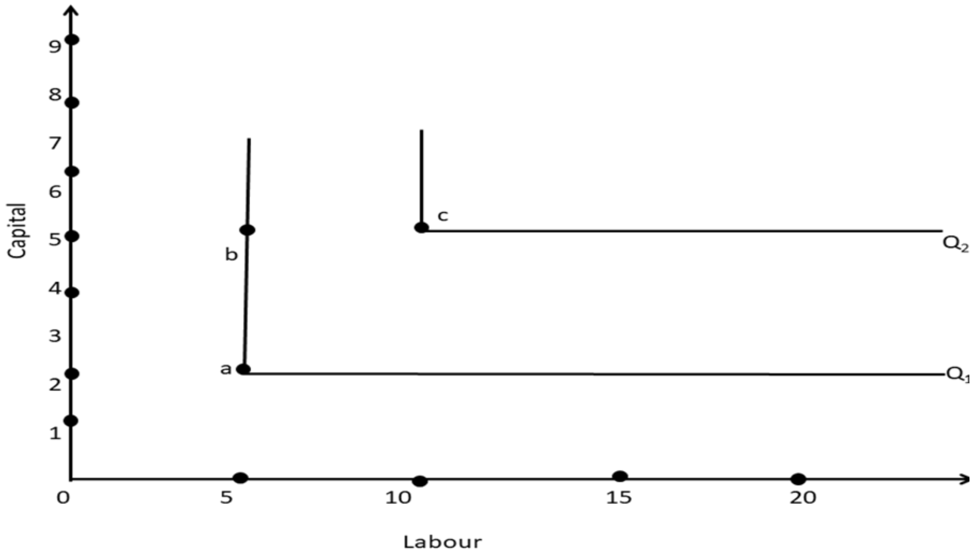

Figure 10.3 : Two Factors Are Perfect Complements

At point 5 units of labour and 2 units of capital give us output Q_1Even if capital rises to 4 as shown by point b, output remains Q_1since for the output to rise to Q_2 labour has to be increased to 10 units as shown by point c.

10.3.4 Isocosts

The output produced by two factors is represented by an isoquant. The prices of factors are represented by an isocost line. The knowledge of isocost line is important in determining what combination of factors a producing unit will choose to produce a given level of output.

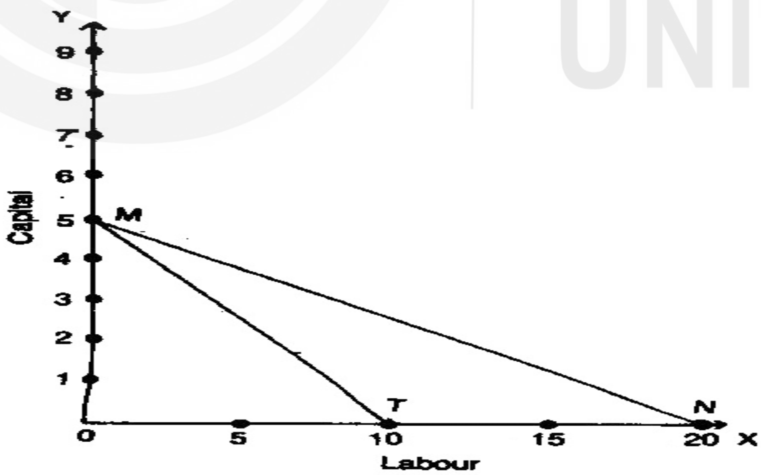

Figure 10.4: Isocost

An isocost line shows various combinations of two factors or inputs which a producing unit can buy with a given money or budget. This line is shown in Figure 10.4.

The method of drawing an isocost line is very simple. We assume that prices of labour and capital are/given to a producing firm. Suppose the firm has to spend Rs 100 and if wage rate is Rs 5 per labourer, then if the whole of money is spent on hiring labour, the maximum number of labourers which can be hired is 100 divided by 5 which gives us 20 and accordingly mark 20 on x-axis. Similarly, if price of capital is Rs 20 per unit, then the maximum of capital which can be bought by the firm is 5 units. Again mark 5 on y-axis. Now, join 5 and 20 by a straight line, this downward slopping straight line will make an intercept at 5 units on y-axis and 20 units on x-axis. This straight line is called isocost line as being shown as MN line in Fig. 10.4.

If the outlay or money with the firm falls isocost line will come down parallel to MN in Fig. 10.5. Conversely it will go up parallel to MN if outlay money with the firm rises. Thus, an isocost line depends up on two things (i) the total outlay which a producing unit has to make on the factors and (ii) prices of the factors of production. The slope of the isocost line is:

$\frac{OM}{ON}$ gives us the ratio of prices of labour to capital

or

$$\frac{OM}{ON} = \frac{\text{price of labour}}{\text{price of capital}}$$

The isocost line will change if prices of factors change outlay remaining the same. For example, if outlay remains Rs 100 but price of labour doubles from Rs 5 to Rs 10 per unit, the firm will be able to hire only 10 labourers, the mice of capital remaining unchanged, the new isocost line will be MT or ratio of prices of two factors will rise from the original OM/ON to OM/OT.

A. OUTLAY CHANGE

An increase in outlay will result in a rightward shift of the isoquant parallel to original Isocost line as shown in Fig. 10.5. This is indicated by shift from line KT to RS.

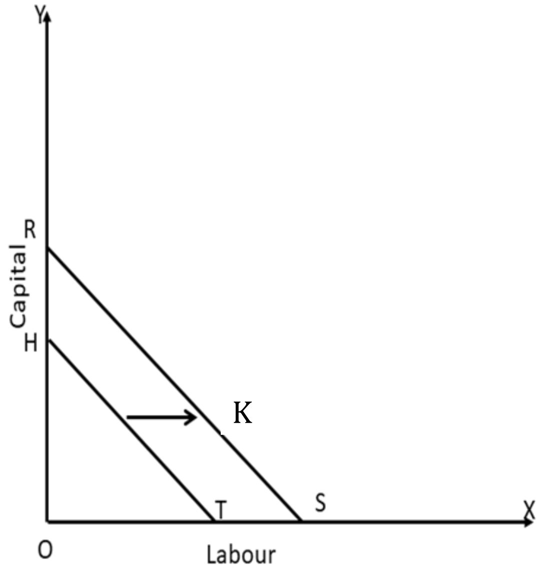

Figure 10.5: Shift in Isoquant due to rise in outlay

Likewise, if the outlay falls the line will shift to the left as shown in Fig. 10.6

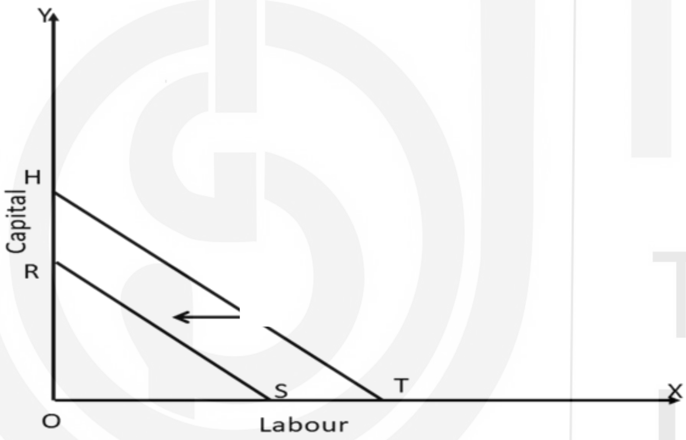

Figure 10.6: Shift in Isoquant due to fall in outlay

10.3.5 Least Cost Combination of Factors

Given isoquant map, representing the technical conditions of production and isocost map, representing various levels of total outlay (given the prices of labour and capital), we can get a producer's-equilibrium in regard to choice of inputs. The producer may desire to minimize his cost for producing a given level of output or he may desire to maximise his output level for a given outlay. Let us take a case where the producer has already decided upon the level of output and is only interested to find out the combination of factors which will minimize his total cost of production such that total profits get maximized. The equilibrium of the producer is represented at point P on the Figure 10.7 at which 10 units of labour and 2.5 units of capital are employed to get a level of output Q_1

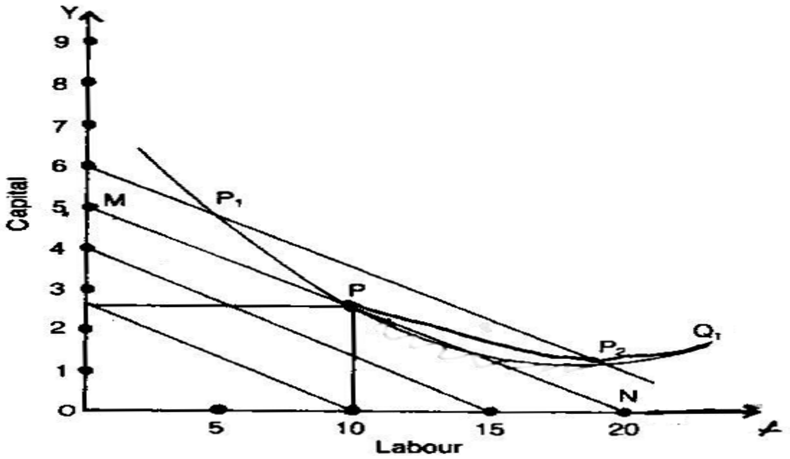

Figure 10.7: Producer's Equilibrium for inputs

The level of output Q_1can be produced by any factor combination such as P, P_1, P_2 lying on the capital isoquant. The total cost, we can see, will be minimum at point P at which the isocost line MN is tangent to the isoquant representing Q_1, output. At no other point, the cost is minimum. So, it is clear that the tangency point of the given isoquant with an isocost line gives us the least cost combination of factors for producing a given output Q_1.

It has already been shown earlier that the slope of the isocost line represents the ratio of price of labour to price of capital. Further, the slope of the tangent on a point on an isoquant represents marginal rate of technical substitution of labour for capital. Thus, at point P the slope of the isocost line and the tangent on the isoquant are the same or

$$\frac{\text{Price of labour}}{\text{Price of Capital}} = \frac{\text{MRTS}}{\text{LK}} = \frac{\text{MPL}}{\text{MPK}}$$

Check Your Progress A

1) What is meant by returns to scale?

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2) What is an Isoquant?

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3) What is an Isocost-line?

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4) List three important properties of an Isoquant?

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5) State whether the following statements are **True** or **False.**

i) In returns to scale, all inputs change in the same proportion.

ii) In the long run we get only constant returns to scale.

iii) If output of a firm goes up by 10% caused by 5% increase in all inputs, we have diminishing returns to scale.

iv) Marginal rate of technical substitution is always equal to price ratio of two factors.

v) In case of perfect substitutes an Isoquant is L Shaped.

vi) An isoquant is convex to the origin because marginal rate of technical substitution remains constant.

10.4 ISOQUANTS AND LAWS OF RETURNS TO SCALE

The concept of Isoquants can be used to express the returns to scale. Look at Figure 10.8 where returns to scale are represented. Four Isoquants have been drawn showing level of output 100, 200, 300, and 400 units. Line OS has been drawn passing through the origin O. As we move along OS, the inputs of labour and capital vary. But since the OS line passes through the origin, the ratio between labour and capital remains the same throughout, though absolute amounts of labour and capital keep rising. So, increase in labour and capital along line OS represents the increase in the scale. Even OT line represents increase in the scale.

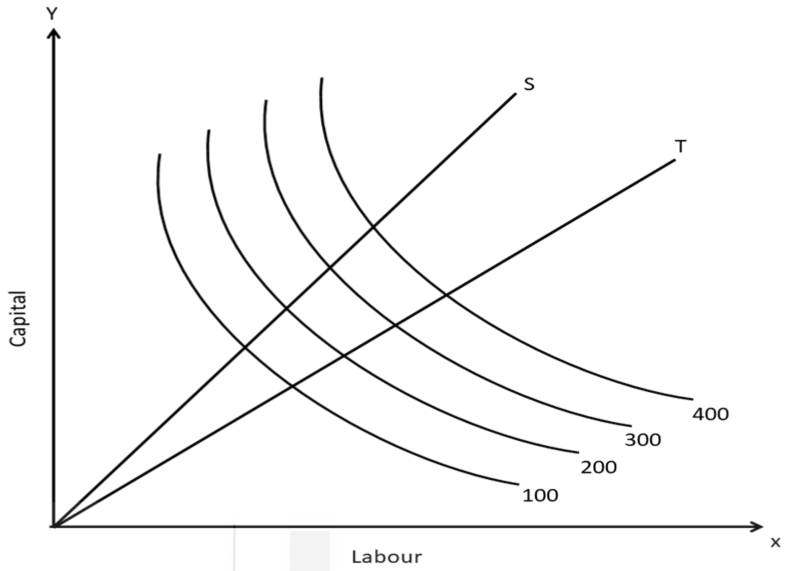

Figure 10.8: Returns to Scale

10.4.1 Constant Returns to Scale

Returns to scale are constant if output increases in the same proportion as the increase in all factors. Constant returns to Scale are shown with the help of Isoquants in Figure 10.9

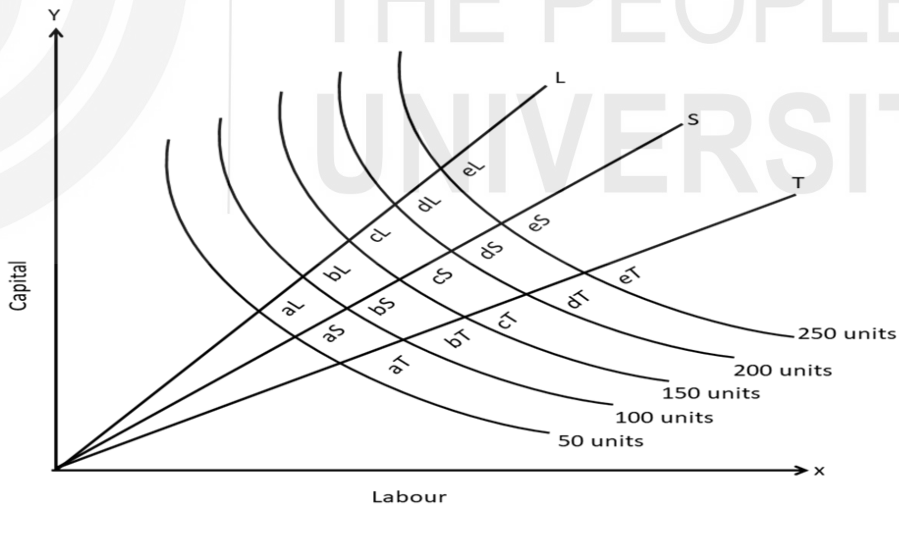

Figure 10.9 : Constant Returns to Scale

Five Isoquants representing output of 50, 100, 150, 200 and 250 units are drawn by taking labour on X-axis and capital on Y-axis. Three rays are drawn from origin labelled OL, OS and OT. It can be seen that successive Isoquants are equidistant from each other along a ray S or T or L.

Thus, along the ray OS;

aS = bS = cS = dS = eS

Similarly,

along the ray OT aT = bT = cT = dT = eT

Finally, if we consider ray OL we find, aL = bL = cL = dL = eL

The same distance between the successive Isoquant means that if both labour and capital are increased in a given proportion, output expands by the same proportion.

10.4.2 Increasing Returns to Scale

Increasing Returns to Scale means that output increases in a greater proportion than increase in all inputs or factors. Increasing returns to scale are shown with the help, of Isoquants in Figure 10.10. Five Isoquants representing output of 50, 100, 150, 200 and 250 units are drawn by taking labour on X-axis and capital on Y-axis. The ray OS is drawn from the origin O. It can be seen that the successive Isoquants lie at decreasing smaller distances along the ray OS. We notice that

bs< as <cs<bs and ds <cs

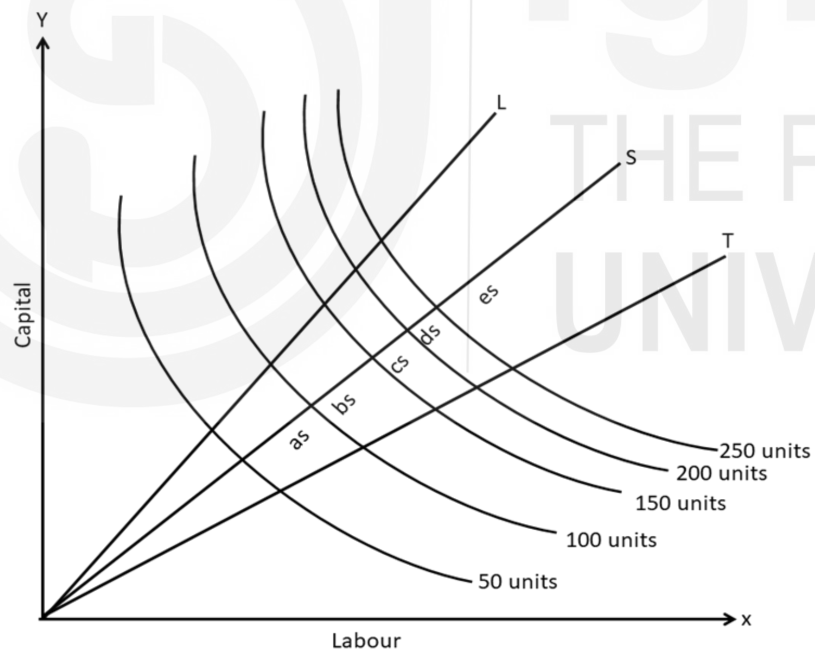

Figure 10.10 : Increasing Returns to Scale

This would hold true on other rays OF and OL also. We regard this as a case of increasing returns to scale because equal increases in output are obtained by smaller and smaller increments in inputs (labour and capital).

10.4.3 Diminishing Returns to Scale

When output increases in a smaller proportion than the increase in all inputs, diminishing returns to scale are said to prevail. Diminishing Returns to Scale are shown is Figure 10.11

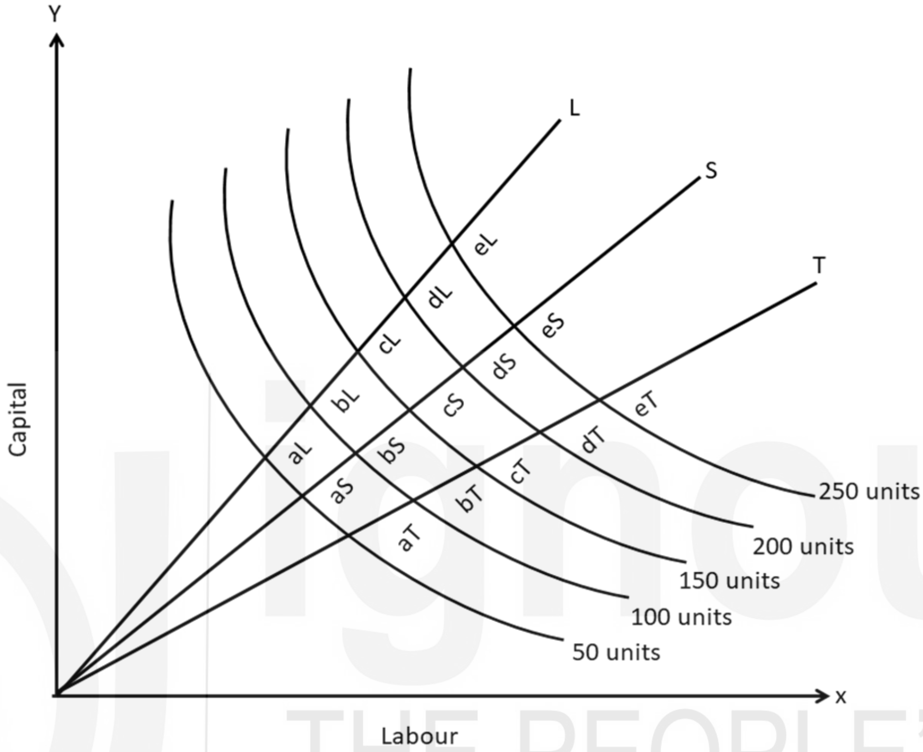

Figure 10.11: Diminishing Returns to Scale

Isoquants representing output of 50, 100, 150, 200 and 250 units are drawn by taking labour on X-axis and capital on Y-axis. The ray OS is drawn from the origin O. It can be seen that the successive Isoquants lie at increasing distances along the ray OS. We notice that

> **For More Clarity!**
>
> In economics, returns to scale and economics of scale are related terms that describe what happens as the scale of production increases in the long-run, when all input levels including physical capital usage are variable (chosen by the firm). They are different terms and should not be used interchangeably.

es> ds >cs>bs

This would hold true on other rays also, we regard this case as one of diminishing returns to scale because equal increments in output are obtained by more and more increments in inputs (labour and capital). You should not get an impression that different production functions exhibit different types of returns to scale; constant, increasing or diminishing. Normally, three phases of increasing, constant and diminishing returns to scale occur in a single production function.

In other words, as a producing firm starts production in the long run or when its scale, increases, first it witnesses increasing returns to scale, then a phase of constant returns, and beyond a point eventually, as the firm continues its expansion, decreasing returns sets in. The reasons for this sequence of increasing, constant and diminishing returns to scale will be analysed in the next section.

10.5 ECONOMIES AND DISECONOMIES OF SCALE

It is important to find out the reasons for the existence of increasing returns to scale and also why does eventually diminishing returns to scale set in? The existence of economies of scale are said to be responsible for the emergence of increasing returns to scale. But the economies of scale cannot continue indefinitely and accordingly the diminishing returns to scale are attributed to the diseconomies of scale.

10.5.1 Economies of Scale

Economies of scale are the advantages which a producing unit enjoys by expanding the size of plant and the scale of operation. These advantages or economies enable a firm to get proportionately larger output than increments in factor inputs or after adjusting all inputs. Optimally, the average cost of production can be reduced by increasing the size of the plant. These economies of scale are also referred to as internal economies because they are peculiar to a particular producing unit and are enjoyed by it by expansion of its own scale of production. Some of the economies of scale are given as follows:

1) **Higher degree of specialisation and division of labour:** As scale of production expands, higher degree of specialisation of both machinery and labour becomes possible. The use of specialised machinery and labour increases productivity per unit of inputs. Their cumulative effects contribute to increasing returns to scale. As scale of production increases more labour is employed and the opportunities for specialisation and division of labour are captured by the producing unit. A larger plant with a larger workforce may enable each worker to specialise in one job, gaining proficiency and waste less time in moving about from one job to another and also in changing tools. Thus, important savings may be realised by increasing the scale of production. The specialisation may also take the form of machinery which a particular machine may be earmarked for a particular task in which it can be best used.

2) **Technical indivisibilities:** Some factors, particularly mechanical equipment, used in the process of production are available in a minimum size. Full use of them can be made only when production is carried on a large scale but because of indivisibility or lumpiness, they have to be employed even at a small level of output. Such inputs cannot be divided into small sizes to suit the small scale of production. Thus because of indivisibility of such factors, they have to be employed in a minimum

quantity even if scale of production is relatively small. Therefore, when scale of production is increased by increasing all inputs, productivity of indivisible factor increases considerably and thus, in turn, results in increasing returns to scale.

3) **Managerial economies:** Like specialised machines, managerial skills are also indivisible. Suppose a manager can optimally supervise 10,000 units of production in a week but only 5,000 units are produced in a week then the managerial cost gets distributed over less units of output. It will be possible to reduce cost per unit until 10,000 units are produced or total output will rise, proportionately more with increments of labour and capital inputs. The extent to which managerial economies can be enjoyed by a producing unit depends on the efficiency of the manager.

4) **Superior machinery :** The increase in the scale of production enables the efficiency of factors to be increased by the introduction of superior and more specialised machinery. So, even if there is no lumpiness of a factor and all factors are proportionately increased, increasing returns may operate because of the possibility of introducing more superior and specialised machinery. The possibility of installing technologically more efficient machinery is an equally important factor responsible for increasing returns to operate initially.

5) **Dimensional relations:** Increasing returns to scale is also a matter of dimensional relations. For example when the size of a room (10'$\times$5' = 50 sq ft) is doubled (20'$\times$10') the area of the room is more than doubled (i.e.= (equal to) 200 sq.ft.)

   Similarly, if we double the number of bricks and other inputs that go with them, the storage capacity of the warehouse is more than doubled. This is thus a case of increasing returns to scale. Similarly, if the diameter of a pipe is doubled, the flow of water is more than doubled. Following the same logic when labour and capital are doubled, the output is more than doubled.

10.5.2 Diseconomies of Scale

Diseconomies of Scale are the disadvantages which a producing unit gets by: expanding the size of the plant or scale of production beyond a particular level. Diseconomies of scale are also referred to as internal diseconomies because they are peculiar to a particular producing unit. Some of the diseconomies of scale can be enumerated as follows:

1) **Limitations to efficient management:** Managing a unit entails controlling and coordinating a wide variety of activities such as production, sales, advertisement, transportation etc. As the scale of plant expands beyond a particular point, top management is forced to delegate responsibility and authority to lower management. This leads to loosening of control and thus the efficiency of operation begins to

decline. Even if all the variable factors are increased in a given proportion, total output does not increase by the same proportion.

2) **Limited uses of the natural resources:** If production is defined as mining of natural resources, then this factor is very important. For example, doubling of coal mining plants may not double the coal output because of limitedness of coal deposits or difficult accessibility to coal deposits. Similarly, doubling the fishing fleet may not double the fish output because the availability of fish may decrease when fishing is carried out on an increasing scale.

It is quite difficult to determine when diseconomies of scale set in and when they become strong enough to outweigh the economies of scale. One thing can be safely stated that diseconomies become important when economies of scale are negligible. Even after the efficiency of management begins to fall, technological economies of scale may offset the diseconomies over a wide range of outputs. Diseconomies of scale primarily arise because of management factor while economies of scale arise because of technological, management or technical indivisibility. It is only when management diseconomies of scale outweigh economies of scale arising because of management and factors the net diseconomies of scale will exist to explain the emergence of diminishing returns to scale.

RESULTS

1. IRS occurs when E > D
2. CRS occurs when E = D
3. DRS occurs when E < D

Where, E = Economies of Scale, and

D = Diseconomies of scale

IRS= Increasing return to Scale

CRS= Constant return to Scale

DRS= Decreasing return to scale

Check Your Progress B

1) What are economies of scale?

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2) Define managerial and technological economies of scale.

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3) What are the diseconomies of scale?

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4) Fill in the blanks.

i) If output increases in the same proportion as the increase in all inputs, we have...............returns to scale.

ii) If successible Isoquants lie at decreasing smaller distances along a ray starting from the origin we have.......returns to scale.

iii) If inputs required increase in large proportion than the total output we have ……….. returns to scale.

iv) A firm first witnesses………………...returns to scale, then. ......returns to scale and finally………....returns to scale.

v) Economies of scale are only available to a firm with the expansion of its...........of production.

vi) Lumpiness of capital is responsible for the existence of ....scale.

vii) Diseconomies of scale explain the existence of ……………….. ....returns to scale.

viii) Diminishing returns to scale is witnessed at the ....by a firm.

10.6 LET US SUM UP

The long run production theory is concerned with input output relationship under the condition that all inputs or factors are variable factors. The laws of returns to scale are studied under the long run production theory. There are three laws of returns to scale:(i) Constant returns to scale, (ii) Increasing returns to scale, and (iii) Diminishing returns to scale.

Constant returns to scale operate when increase in the total output is proportional to the increase in inputs or factors. Increasing returns to scale operate when total output is greater than the proportional increase in the inputs. Diminishing returns to scale arise when increase in output is less than proportional to the increase in inputs. The laws of returns to scale can also be explained with the help of production function.

An isoquant is a curve on which the various combinations of two factors say labour and capital give us the same level of output per unit of time. An isoquant slopes downwards from left to right, two isoquants cannot intersect each other and it is convex to the origin. The convexity of an Isoquant implies that marginal rate of technical substitution between two factors falls as more of a factor is employed.

Marginal rate of technical substitution of labour for capital is defined as the amount of capital which can be replaced by one unit of labour, the level of output remaining the same. Marginal rate of technical substitution of labour for capital is equal to the ratio of marginal physical product of labour to capital. It is also given by the slope tangent drawn at a particular point on the isoquant.

In case of perfect substitutes of two factors, the isoquant is a straight line implying constancy of marginal rate of technical substitution. In case of perfect complements of two factors, the isoquant is L-shaped. An isocost line represents various combinations of two factors which can be bought with a given money or budget. The slope of an Isocost line represents the price ratio of labour to capital.

Given an isoquant and a map of isocost a producer can find out that combination of factors which will minimise his total cost of production such that total profits get maximised. This happens at a point where ratio of price of labour to capital is equal to marginal rate of technical substitution of labour for capital which is also equal to ratio of marginal physical product of labour to capital.

The laws of returns to scale can be represented with the help of isoquants. If the distance between the successive isoquants remains the same along a ray passing through the origin, we have constant returns to scale. If successive distance between the successive isoquants keeps falling, increasing returns to scale exist. Similarly, if successive distance between the successive isoquants keeps rising, diminishing returns to scale exist. A producing firm first witnesses increasing returns to scale, then

Increasing returns to scale arise because of an emergence of economics of scale which are the advantages production units enjoys by expanding the scale of operations. Economies of scale arise because of (1) higher degree of specialisation and division of labour, (2) technical indivisibilities or lumpiness of some factors, (3) managerial indivisibility, (4) superior techniques being employed and, (5) dimensional relations.

Diseconomies of scale or disadvantages of the expansion of scale of output primarily arise because of management increasingly losing control over various operations of the production unit. Sometimes, diseconomies of scale also arise because of limitedness of the natural resources. Diseconomies of scale explain the existence of diminishing returns to scale.

10.7 KEY WORDS

Constant Returns to Scale: A simultaneous and proportionate increase in all the inputs leading to proportionate increase in total output.

Convexity of an Isoquant: The falling tendency of marginal rate of technical substitution on an Isoquant.

Diseconomies of Scale: The disadvantages faced by a producing unit by enlarging its scale of production.

Equilibrium of a Producer: Given output he likes to combine factors in a manner that total cost is minimized or given input he likes to produce that level of output at which total profits are maximized.

Economies of Scale: The advantages enjoyed by a producing unit by enlarging its scale of production.

Increasing Returns to Scale: A simultaneous and proportionate increase in all the inputs leading to more than proportionate increase in total output.

Isoquant: Curve on which the various combinations of two factors give the same amount of output. Most typically, an isoquant shows combinations of capital and labour and the technological trade-off between the two.

Isocost Line: Various combinations of two factors which can be bought with a given money or budget.

Marginal Rate of Technical Substitution: The amount of a factor which can be replaced by one unit of another factor the level of output remaining the same.

Perfect Substitutes: The marginal rate of technical substitution of two factors is constant.

Perfect Complements: Proportion in which two factors are combined is fixed.

Ray: A line passing through the origin cutting across Isoquants.

Returns to Scale: A simultaneous and proportionate increase in all the inputs affecting the total output.

Slope of an Isoquant: The marginal rate of technical substitution of a factor for another factor.

Technical Indivisibility: A factor which cannot be divided into as small units as one likes.

10.8 ANSWERS TO CHECK YOUR PROGRESS

Check your progress A

5 (i) True (ii) False (iii) True (iv) False (v) False (vi) False.

Check your progress B

4 (i) Constant (ii) Increasing (iii) Diminishing (iv) Increasing, Constant, diminishing(v) Scale (vi) Economics (vii) Diminishing (viii) Last Stage

10.9 TERMINAL QUESTIONS

1) What is meant by returns to scale?
2) Explain the concept of Isoquant and Isocost.
3) Explain returns to scale with the help of a Production Function.
4) Distinguish between increasing and diminishing returns to scale with the help of Isoquants.
5) Explain with the help of Isoquant and Isocost the least cost combination of factors to achieve a given level of output.
6) Define marginal rate of technical substitution of capital for labour. Use a diagram.
7) What are the properties of an Isoquant?
8) Derive the Isoquants if two factors are perfect substitutes and perfect complements.
9) What is meant by economies of scale? How do they explain increasing returns to scale?
10) What are the main types of economies of scale?
11) Explain the concept of diseconomies of scale?

Note: These questions will help you to understand the unit better. Try to write answers for them. But do not submit your answers to the university for assessment. They are for your practice only.

UNIT 11 THEORY OF COSTS AND COSTCURVES

Structure

11.0 OBJECTIVES

After studying this unit, you should be able to:

- identify the factors determining cost
- distinguish various types of costs ,
- trace the shape of short run cost curves
- explain marginal cost
- distinguish between fixed and variable costs
- make cost schedule and draw various related cost curves
- explain why an average cost curve is U-Shaped
- find out the relation between short run cost and long run cost.

11.1 INTRODUCTION

In previous units have learnt the relation between inputs or factors and outputs. Inputs used to produce output are available only at a price. Therefore, the generation of output over a period is possible only at a cost. The producer would like to minimise his cost. In this unit you will study the determinants of costs. You will be introduced to the concepts of accounting costs, economic costs, opportunity cost, private cost, social cost and real cost. The short run average cost, short run marginal cost, fixed and variable costs, and the long run cost will be introduced. How do various costs behave with change in the level of output will also form a part of the contents of this unit.

11.2 THEORY OF COSTS

Theory of costs of a producing firm relates total cost to the level of output. We may construct a table including the level of costs at various levels of output. This table is called the cost schedule. Similarly, the costs may be expressed in a mathematical form which is called the cost function. Finally, the relation of total costs to output may be expressed in the form of a curve which is referred to as the total cost curve.

The cost of production of a firm is determined by the following factors.

1) **Physical conditions of production :** The generation of output of a firm depends on the nature of inputs required to give rise to a particular level of output. This information we get from production function which is already introduced to you in unit 8 and unit 9.

2) **Price of factors of production :** The physical inputs required to get a level of output are no doubt given by the nature of production function. But the inputs are available to a firm at a particular price. For example, labour is available at a particular wage, capital at a particular interest and land at a specific rent. Similarly, an entrepreneur works for profit. The determination of wage, interest, rent and profit will be discussed subsequently. The product of physical units of an input and price of an input give us cost of that input. The addition of the value of all the inputs give us total cost of production.

3) **Efficient use of inputs :**In Unit 9 the operation of least cost combination of inputs to get a level of output has been introduced. The tangency of isocost line to the isoquant gives us the least cost combination of inputs. It is also explained that the tangency also implies the equality of marginal rate of technical substitution with the input price ratio. Thus, if a firm aims at minimising costs we can get the total cost at different levels of output. It will be assumed that for each level of output the firm chooses least cost combination of inputs. In other words, the firm chooses an input combination which lies on the expansion path corresponding to a given level of output.

11.3 ECONOMIC COSTS

The Concept of Economic Cost is used in Economic Theory. It includes explicit and implicit costs. Explicit cost include the payment and charges made by the entrepreneur to the suppliers of various productive factors like land, labour, capital and raw materials. Thus, the rent paid for the building hired by the firm, wages paid to the labourers hired, interest paid on the money borrowed for doing business and prices paid for the raw materials, fuel and power, etc. used together constitute explicit costs.

Implicit cost consists of (a) the normal return on capital invested by the entrepreneur himself in his own business, which he could have earned had he invested his capital in a venture other than his own. (Suppose, a producer invests Rs 10,000 to start a business out of his personal resources. Had he invested this capital somewhere else he would have been able to get a return of say, Rs 1,000 per year. Thus, Rs 1,000 is one component of implicit costs.) (b) the wages or salary the entrepreneur could have earned had he sold his services to others. Again suppose the entrepreneur instead of starting his own business decided to work as a manager with some other firm at a salary of Rs. 2,000 per month, then Rs 2,000 is another component of implicit costs.

The implicit costs, thus, incurred in producing a commodity or service is the amount that could be earned in the best alternative use of the entrepreneur's money (or capital) and time. Given implicit costs, economic costs can be defined as follows:

Economic costs =Explicit costs + Implicit costs

An economist whenever he refers to costs has in mind the concept of economic costs. Accordingly, economic profits are equal to total revenue (Price X Quantity sold) minus total economic costs. Even if total revenue is equal to total economic costs, the firm still enjoys some profits (called normal profits equal to implicit cost) though economic profits are equal to zero. These details will be explained subsequently.

Check Your Progress A

1) What are economic costs?

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2) Distinguish between implicit costs and explicit costs.

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3) Fill in the blanks

   i) For economist by costs mean ....

   ii) When total revenue is equal to total economic costs, economic profits are equal to...

   iii) Economic costs =..................... + ...

   iv) Wages paid by a firm to the labour hired are..............costs.

   v) If an entrepreneur instead of working in some other firm and getting Rs. 20,000 p.m. as salary, starting his own business, then Rs. 20,000 is........

11.4 SHORT RUN COST CURVES

The short run is analytically defined as a situation in which the inputs of some factors cannot be varied even if the level of output changes. These inputs which cannot be changed are called fixed inputs or fixed factors. There are other inputs or factors which are increased with more output and decreased with less output. The inputs or factors that can be varied in the short run are called variable inputs or variable factors. The short run should not be confused with calendar period. The salient feature of short run is that there are some factors which are fixed and there are others which are variable.

Fixed and Variable Costs

Fixed Costs are those which do not vary with output. It can also be stated that fixed costs are the costs of employing fixed factors which by definition, do not undergo a change in the short run. **The total cost of employing fixed factors in the short run is called total fixed costs.** The fixed costs include costs such as (i) salaries of managerial and administrative staff, (ii) rent of building, and (iii) interest on capital.

Variable costs are all those costs that vary directly with output, increasing as more is produced and decreasing as less is produced. Alternately variable costs are the costs of employing variable factors. The total cost of employing variable factors is called total variable costs. Variable costs are also known as direct costs or prime costs. Variable costs include cost of (i) raw materials, (ii) running plant and machinery, such as fuel, routine maintenance, and (iii) unskilled and semi-skilled labour etc. **Total cost of producing any level of output is the sum of total fixed cost and total variable cost. Since total fixed cost remains fixed by definition, the variation in total cost can be explained only by change in total variable cost**.

Total cost divided by total quantity produced gives us average cost or also known as **average total cost.** Total fixed cost divided by the number of units produced gives us **average fixed cost**. Total variable cost divided by the number of units produced gives average variable cost. The average total cost can also be arrived by adding an average fixed cost and average variable cost.

The relation between various costs can be summarised as follows:

TC = TFC + TVC (i)

Where TC stands for total cost, TFC for total fixed cost and TVC for total variable cost. If variable in (i) are divided by units of quantity produced (Q) we get average costs.

$$\frac{TC}{Q} = \frac{TFC}{Q} + \frac{TVC}{Q} \qquad \text{(ii)}$$

or

$$ATC = AFC + AVC \qquad \text{(iii)}$$

Where ATC is average total cost, AFC is average fixed cost and AVC is average variable cost.

11.4.2 Marginal Cost

Marginal Cost is defined as the increment in total cost required to produce one extra unit of output. This can be explained with the help of an example.

Suppose the total cost of producing 10 units of a commodity is Rs. 1,000 and the total cost of producing 11 units of the same commodity is Rs 1,100. Then marginal cost of producing the 11th unit of the commodity is Rs. 1,100-Rs 1,000 = Rs 100

MC of (X + 1) th unit is TC of X +1 units minus TC of X units. Where X stands for units of the commodity produced.

Since only variable cost changes in the short run, marginal cost of (X + 1)th unit can be defined as TVC of X+1 units minus TVC of X units.

If output of a commodity does not change by precisely one unit, MC is defined as $\frac{\Delta TVC}{\Delta Q}$ where ΔTVC represents change in total variable cost and ΔQ change in units of commodity produced.

PROOF

$$MC_N = \frac{\Delta TC}{\Delta Q}$$

$$= \frac{\Delta TVC + \Delta TFC}{\Delta Q}$$

$$= \frac{\Delta TVC}{\Delta Q} + \frac{\Delta TFC}{\Delta Q}$$

$$= \frac{\Delta TVC}{\Delta Q} + \quad \text{Zero}$$

(Since TFC remains the same at all level of Output, ΔTFC will always be zero)

$$= \frac{\Delta TVC}{\Delta Q}$$

i.e. MC is determined only by TVC

11.4.3 Cost Schedule

Let us represent various costs, discussed above, in relation to the level of output with the help of the following schedule representing hypothetical data.

Table 11.1 Tabular Representation of **Cost Schedule**

Q	TFC	TVC	TC	AFC	AVC	ATC	MC
Quantity Of output (units) (1)	Total fixed cost (Rs) (2)	Total variable cost (Rs) (3)	Total cost (Rs) (4)	Average Fixed Cost (Rs.) (5)	Average Variable Cost (Rs.) (6)	Average total cost (Rs.) (7)	Marginal Cost (Rs.) (8)
0	400	-	400.00	-	-	-	-
1	400	40.00	440.00	400.00	40.00	440.00	40.00
2	400	64.00	464.00	200.00	32.00	232.00	24.00
3	400	84.00	484.00	133.33	28.00	161.33	20.00
4	400	104.00	504.00	100.00	26.00	126.00	20.00
5	400	120.00	520.00	80.00	24.00	104.00	16.00
6	400	144.00	544.00	66.67	24.00	90.67	24.00
7	400	182.00	582.00	57.14	26.00	83.14	38.00
8	400	224.00	624.00	50.00	28.00	78.00	42.00
9	400	288.00	688.00	44.44	32.00	76.44	64.00
10	400	360.00	760.00	40.00	36.00	76.00	72.00
11	400	436.00	836.00	36.36	39.64	76.00	76.00
12	400	521.60	921.60	33.33	43.48	76.81	85.60
13	400	640.00	1040.00	30.76	49.24	80.00	118.40
14	400	792.00	1192.00	28.56	56.64	85.20	152.80
15	400	998.00	1398.00	26.68	66.52	93.20	205.20
16	400	1296.00	1696.00	25.00	81.00	106.00	298.00
17	400	1674.00	2074.00	23.52	98.48	122.00	378.00

18	400	2156.00	2556.00	22.24	119.76	142.00	482.00
19	400	2792.00	3192.00	21.04	146.96	168.00	636.00
20	400	3600.00	4000.00	20.00	180.00	200.00	808.00

The calculations in the Table 11.1 are explained below:

1) TFC given in Column 2 are given irrespective of the level of output and therefore is taken as Rs 400 throughout.

2) TVC given in Column 3 is rising with increase in output.

3) TC in Column 4 is addition of TFC of Column 2 and TVC of Column 3 at each level of output. For example when output is 2 units, TFC is 400, TVC is 64 and therefore, TC is 400+ 64 = 464.

4) AFC in Column 5 is TFC of column 2 divided by quantity of output in Column 1. For instance, AFC at 3 units of output is Rs 400 divided by 3 equal to Rs. 133.33

5) AVC in Column 6 is TVC of Column 3 divided by quantity of output of Column 1. For example when output is 4; TVC is 104 and, therefore, AVC is 104 divided by 4 equal to 26.

6) ATC in Column 7 is TC of Column 4 divided by quantity of output of Column 1. For example when output is 5, TC is 520 and, therefore, ATC is 520 divided by 5 equal to 104.

   Alternately ATC can be found out by adding AFC of column 5 and AVC of Column 6 at each quantity of output. Thus, when output is 5, AFC is 80 and AVC is 24 and hence ATC is 80 plus 24 equal to 104.

7) MC in Column 8. is arrived at by subtracting TC of given quantity of output from TC of quantity of output increased by one unit. Thus TC of 4 units of output is Rs 504 and TC of 14+1 = 5 units of output is Rs. 520 as given in Column 4. From Rs 520 deduct Rs. 504 we get Rs 16 which is the MC of 5th unit of output. Alternately MC can also be found out by utilising TVC data. TVC of 5 units of output is Rs 120 and TVC of 4 units of output is Rs. 104 and, therefore, MC of 5th unit of output is Rs 120 minus Rs 104 equal to Rs. 16.

11.4.4 Total, Fixed and Variable Cost Curves

The information given in Table 11.1 will be represented in two parts.

i. Total cost curves, and

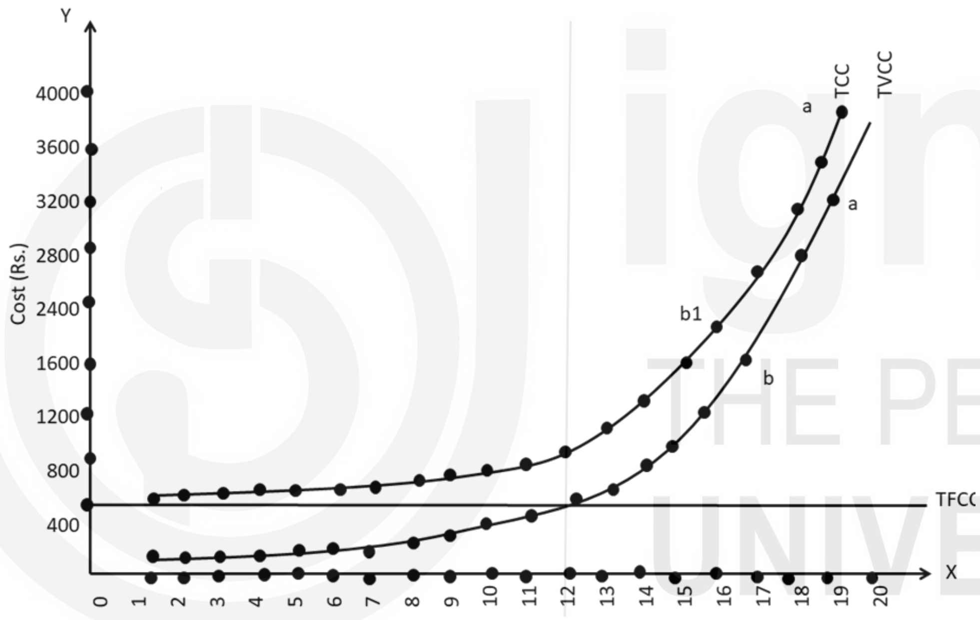
ii. Per Unit Cost curves

In this section the data contained in columns 1, 2, 3 and 4 will be represented with the help of total fixed cost curve (TFCC), total variable cost curve (TVCC) and total cost curve (TCC) as shown in Figure 11.1.

On the X-axis quantity of output is measured and on the Y-axis cost is measured in rupees. For each quantity of output TFC remains fixed at Rs. 400. Accordingly, TFCC is parallel to X-axis. Even when quantity of output is zero, TFC is Rs 400 and it remains the same throughout.

TVC rises with increase in quantity of output. So, corresponding to each quantity of output TVC is measured along Y-axis and then TVC of each level of output is represented by a point on the graph. For example, point a on TVCC represents TVC of Rs 3,600 when quantity of output is 20 units. Similarly, point b on TVCC represents TVC of Rs 1,296 when quantity of output is 16 units.

TCC is arrived at by joining various points representing TC=(TFC + TVC) at different quantities of output. Take for instance quantity of output as 20 units at which TVC is Rs 3,600 and TFC is Rs 400. Such that TC is Rs 4,000 which is represented by a point a'. Further if quantity of output is 16. units TVC is Rs 1,296 and TFC is Rs 400. Such that TC is Rs 1,696 which is represented by point *b'. Join all such points as a' and 'b' we get TCC. There are 20 points on the TCC just like there were 20 points on TVCC.



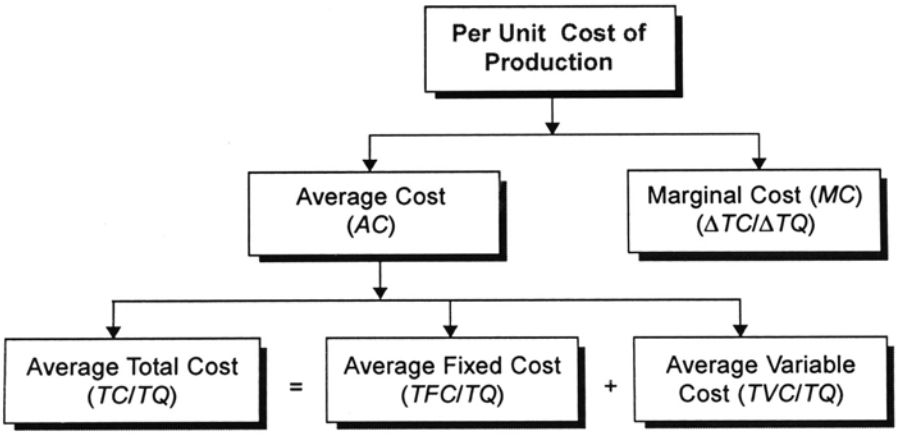
Quantity of output

Figure 11.1 :Graphical Representation of Total, Fixed and Variable Cost Curves

11.4.5 Average Total, Average Fixed, Average Variable Cost Curves and Marginal Cost Curve

Data contained in Columns 5, 6, 7 and 8 of Table 11.1 can be represented graphically by drawing average total cost curve (ATCC) average fixed cost curve (AFCC), average variable cost curve (AVCC) and marginal cost curve (MCC) respectively. These curves are represented in Figure 11.2.

In Figure 11.1 TFCC takes the form of a horizontal line because TFC remains fixed for the whole range of output. The TVCC shows that the total variable cost first increases at a decreasing rate and then, at an increasing rate with the increase in output. The rate of increase can be obtained from the slope of TVCC. The reason for the behaviour of AVCC will be analysed in the Section 11.4.6. The vertical distance between TCC and TVC denotes TFC at different levels of output. The vertical distance between TCC and TVCC remains the same because TFC remains fixed in the short run, irrespective of level of output.



In Figure 11.2 AFC is shown with the help of AFCC, AFC is shown declining continuously signifying that as quantity of output increases, AFC falls though TFC remains fixed since AFC $=\frac{TFC}{Q}$

AVC first falls, reaches a minimum at point 'a', and rises thereafter. When AVC is at its minimum at point 'a', MC equals AVC. ATC first declines, reaches a minimum at point c, and rises thereafter. When ATC is at its minimum at point c, MC equals ATC. Further MC first declines, becomes minimum at point 'b' and rises thereafter. It is already noted that MC equals both AVC and ATC when these are at their minimum.

It is worth noting from the Figure 11.2 that

1) MC curve lies below both AVC curve and ATC curve over the range in which the curves are declining; it lies above them when they are rising.

2) As AFC curve comes nearer to horizontal axis, AVC curve keeps coming nearer to ATC curve. The vertical distance between ATC curve and AVC curve at a given quantity of output represents AFC and since AFC keeps falling with increase in quantity of output, the gap between ATC curve and AVC curve keeps falling. Thus, given ATC curve and AVC curve, the shape of AFC curve can always be deduced.

3) ATC curve can be drawn by joining the points given by the addition of AFC and AVC at different quantities of output.

4) ATC curve is U-shaped signifying that as quantity of output increases in the short run, the average cost keeps falling up to a point c and then begins to rise, and

5) AVC curve and MC curve also show a tendency to fall with increase in quantity of output and finally begin to rise.

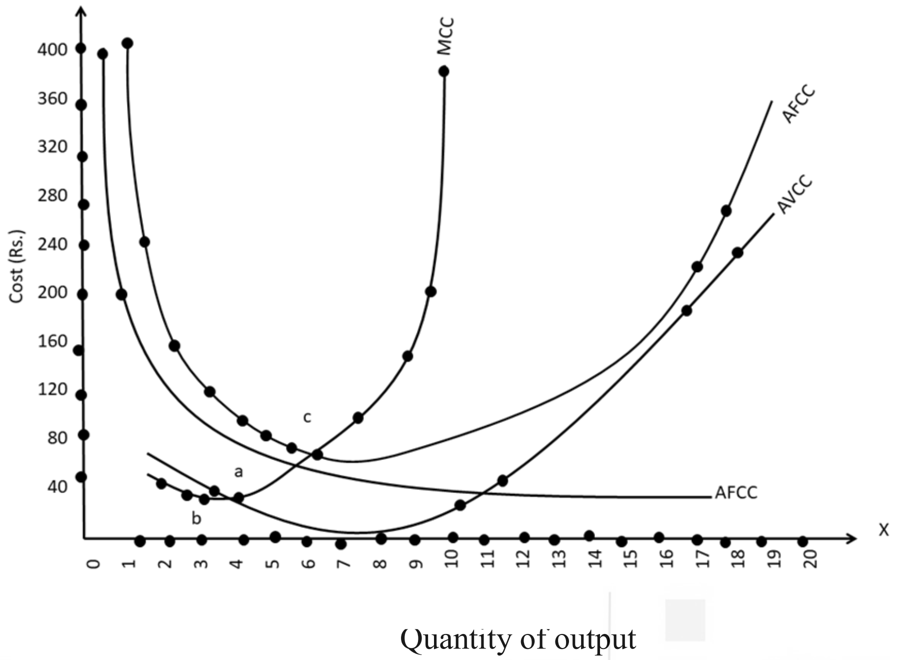


Figure 11.2 :Graphical Representation of Average, Total, Fixed and Variable Cost Curves

The MCC reaches its minimum point at lower level of output than AVCC. For example, MC is lowest at 5 units of output and AVC is lowest at 6 units of output. AC, on the other hand, becomes minimum at 11 units of output.

11.4.6 Shape of Average Variable Cost Curve

It is important to analyse why does AVC first declines and eventually begins to rise? The explanation for this behaviour of AVC lies in the application of the law of variable proportions which is discussed in Unit 9. In a simple way this can be shown as follows.

$$AVC = \frac{TVC}{Q} \qquad (i)$$

(i) TVC is price of a variable factor (P) multiplied by a quantity of variable factor employed (V) such that relation (i) can be represented as

$$AVC = \frac{P(V)}{Q}$$

Or

$$AVC = P\left(\frac{(V)}{Q}\right) \qquad (ii)$$

Quantity produced (Q) divided by amount of variable factor employed (V) gives us average product of variable factor so that

$$AVC = \frac{P(1)}{APv} \qquad (iii)$$

where APv is average product of variable factor.

Now, we can see as more of a variable factor is employed, average product of variable factor rises, given to us by the law of variable proportions and given the price of the product, $\frac{P(1)}{APv}$ tends to fall. Beyond a point, as APV falls, $\frac{P(1)}{APv}$ rises. Hence, average variable cost APV first falls, becomes minimum and finally rises, giving a U-shaped curve.

11.4.7 Why Short-run Average Cost Curve is U shaped?

Average cost curve is normally U-shaped. The reason for this lies simply in the fact that average cost curve is constituted of average fixed cost curve and average variable cost curve.

Average fixed cost keeps falling throughout with increase in the quantity of output and average variable cost first falls, becomes minimum and then rises. Initially when average variable cost falls, (average fixed cost anyway is also falling,) it leads to a fall in average total cost and, therefore, ATC slopes downwards with increase in quantity of output. Then average variable cost begins to rise but average fixed cost continues to fall and till the rise of AVC is less than fall of AFC, ATC continues to fall. Finally, when the rise in AVC is more than the fall in AFC, ATC begins to rise and thus giving us U-shaped ATC.

MCC is also U-shaped. The reason for this is that given the law of variable proportions, marginal product of variable factor normally first rises, reaches a maximum, and finally declines.

Accordingly, given MC = P(1)/MPv, where MPv is marginal product of variable factor. Marginal cost which is the addition to TC or TVC with addition to one unit of output, first declines, reaches a minimum and rises thereafter. Here, MCC takes the shape of U Curve.

11.4.8 RELATIONSHIP BETWEEN MARGINAL COST (MC) AND AVERAGE COST (AC)

The relationship between marginal cost and average cost is an arithmetic relationship. To understand this relationship let us take a numerical example.

The Table 11.2 shows the marginal costs, total costs and average costs at different levels of output.

Table 11.2: Cost Schedule

Output (Units)	Total cost (Rs.)	Marginal cost (Rs.)	Average cost (Rs.)
(1)	(2)	(3)	(4)
1	60	60	60
2	110	50	55
3	162	52	54
4	216	54	54
5	275	59	55

Column 2 shows the total cost of producing different levels of output.

Column 3 shows the increase in total cost resulting from the production of one more unit of output.

(It is called marginal cost. Thus $MC_n = TC_n - TC_{n-1}$, where n and n-1 are levels of output).

Column 4 shows the average cost at different levels of output: $AC_n = \frac{TC_n}{N}$

This table shows that:

1) Average cost falls only when marginal cost is less than average cost. Upto the third unit of output, the marginal cost is less than the average cost and average cost is falling. When 2 units are produced the marginal cost is Rs. 50 which is less than the previous average cost (Rs. 60), now average cost falls from Rs. 60 to Rs. 55. When 3 units are produced, the marginal cost is Rs. 52 which is less than the average cost of 2 units (Rs. 55) so once again the average cost falls from Rs. 55 to Rs. 54.

2) Average cost will be constant when marginal cost is equal to average cost. When 4 units are produced, average cost does not change (It is Rs. 54 when 3 units are produced and remains Rs. 54 when 4 units are produced) because marginal cost (Rs. 54) is equal to average cost (Rs.54).

3) Average cost will rise when marginal cost is greater than average cost. When 5 units are produced average cost rises from Rs. 54 to Rs. 55, because the marginal cost (Rs. 59) is greater than the average cost (Rs. 54).

This relationship between marginal cost and average cost is a generalized relationship and holds good in case of the marginal and average values of any variable, be it revenue or product etc.

In the box a simple proof of the relationship is given: This is for reference only.

Suppose AC falls. Then:

$$\frac{TC_n}{N} < \frac{TC_{n-1}}{n-1}$$

Multiplying both sides by n we get,

$$TC_n < TC_{n-1} \times \frac{n}{n-1}$$

$$TC_n < TC_{n-1} \times \left(1 + \frac{1}{n-1}\right)$$

$$TC_n < TC_{n-1} + \frac{TC_{n-1}}{n-1}$$

$$TC_n - TC_{n-1} < \frac{TC_{n-1}}{n-1}$$

Since the left hand side is MC, and the right hand side is AC, it proves that

$MC < AC$

Thus a fall in average cost means marginal cost is less than average cost. It can similarly be proved that a rise in average cost means, marginal cost is greater than average cost and a constant average cost means marginal cost is equal to average cost.

The relationship between marginal cost and average variable cost is similar to the relationship between marginal cost and average cost because marginal cost is not affected by fixed cost.

Check Your Progress B

1) Distinguish between average fixed cost and average variable cost.

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2) Complete the following table.

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Units of output	TFC (Rs)	TVC (Rs.)	TC (Rs)	MC (Rs.)
0	100	—	—	—
1	—	—	—	40
2	—	—	—	30
3	—	—	—	50
4	—	—	—	60
5	—	—	—	70

3) State whether the following statements are**True** or **False.**

i) When marginal cost is minimum average variable cost is equal to marginal cost.

ii) When marginal cost first begins to fall, average variable cost begins to rise.

iii) When average product is increasing, average variable cost is falling.

iv) Average fixed cost remains the same as output rises.

v) Average fixed cost falls as marginal cost increases.

vi) Average total cost falls as average variable cost decreases.

vii) Marginal cost cannot increase when average total cost is falling.

viii) The gap between ATCC and AVCC falls with rise in quantity of output only in the long run.

ix) Since ATC=AFC + AVC, therefore, marginal cost is equal to marginal fixed cost plus marginal variable cost.

x) MC is zero when total cost is maximum.

11.5 LONG RUN COST CURVES

The long run is defined as that period of time in which all factors or inputs are variable. The long run is also that time in future (or planning horizon) when output changes can be planned by the entrepreneur in a manner such that it is most advantageous to him.

In the short run, the entrepreneur has to take the given plant as fixed and can produce more only by using the given plant for more time per day.

In the long run, he can plan even to set up additional productive capacity, keeping the time for which machine runs as unchanged. It would be correct to say that **the long run consists of all possible short run situations among which the entrepreneur or other economic agents may choose.** Most of the planning is normally done in the long run while the actual operation takes place in the short run.

In unit 9, least cost combination of inputs is already explained. We assume that in the long run each alternative output can be produced by the least cost combination of inputs. Given the factor prices, we can find out the cost to be associated with a given level of output and thus, a long run total cost curve can be arrived. Given the long run total cost curve one can draw long run average cost curve and a long run marginal cost curve.

11.5.1 Long Run Average Cost Curve

In the long run, none of the factors is fixed and all can be varied to expand output. In the short run, the size of plant is fixed and it cannot be changed. In other words, we cannot change the capital equipment in the short run even if size of output is to be changed. In the long run we are permitted to change the size of plants in order to expand or reduce output. Given the least cost combination of output, long run cost curve shows the functional relationship between output and the long run cost of production. **Long run average cost is the long run total cost divided by the quantity of output planned in the long run.**

In order to understand how the long run average cost curve is derived, let us consider two short run average cost curves as shown in Figure 11.3

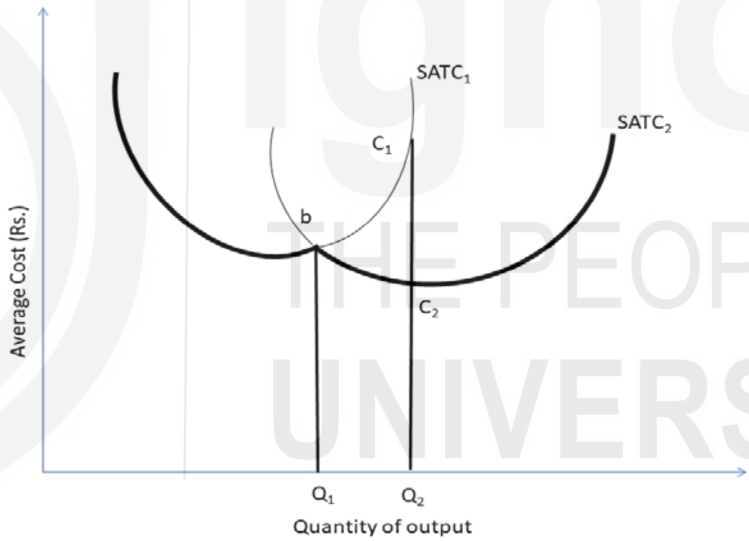

Figure 11.3 :Short Run Average Cost Curve

Two short run average total cost curves are drawn labelled $SATC_1$, and $SATC_2$. These cost curves are also called plant curves. In the short run, the firm can operate only on short run average cost curve, given the size of the plant. We have taken that only these two are the technically possible sizes of plant. Given the short run average cost curve as SATC, the firm will increase or decrease its output by varying the amount of the variable inputs. For example, to produce OQ output in the short run, the firm has no option but to have average short run cost equal to $Q_1.C_1$ as given by $SATC_1$. In the long run, since the firm has a choice to set up a bigger sized plant represented by $SATC_2$, the same OQ, level of output can be produced at Q_1C_2 average cost given by $SATC_2$. In the long run, the firm will examine on which short run average cost it should operate to produce a given level of output at the minimum possible cost. Thus, in the short run the firm's average cost of production will be Q_1 C_1, for OQ_1, level of output and it will get reduced to $Q_1.C_2$ in the long run.

One can easily see from Figure 11.3 that up to OQ_0 level of output, the firm will operate on the short run average cost curve $SATC_1$, though it could also produce with short run average cost curve $SATC_2$, because up to OQ_o level of output, production on $SATC_1$, gives lower cost than on $SATC_2$. So, upto OQ_o level of output, smaller plant $SATC_1$, is more economical than the larger plant $SATC_2$. We have shown only two plant case. A multiple plant case can also be easily depicted. The overall conclusion that can be arrived is that in the long run the firm will employ that plant which yields possible minimum unit cost for producing a given level of output. Given the two plant case, shown in Figure 11.3, the long run average cost curve is the curve which is shown by dark line. This long run curve consists of some segments of all the short run average cost curves.

If the size of the plant can be varied by infinitely small amount such that there are infinite number of plants corresponding to which there will be numerous short run average cost curves, then the long run average cost curve will be smooth and continuous. Such a smooth long run average cost curve is shown in Figure 11.4.

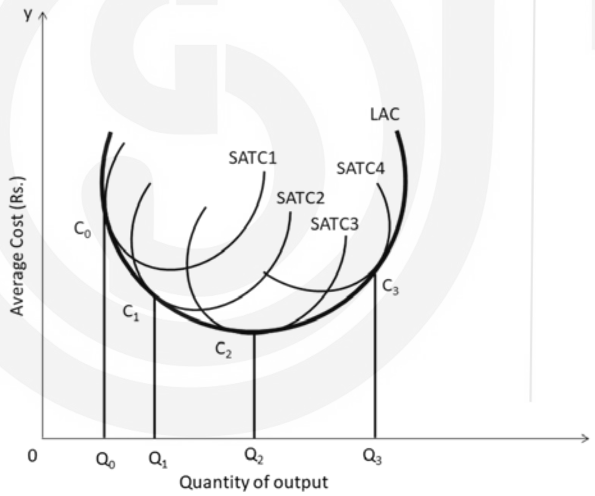

Figure 11.4: Long Run Average Cost Curve

The short run average cost curves are indicated by $SATC_1$, $SATC_2$, $SATC_3$ and $SATC_4$and the long run average cost curve is shown by dark line. If the firm plans to produce a particular level of output in the long run, it will choose a point on the long run average cost curve corresponding to that level of output and will then plan to build a relevant plant and operate on the corresponding short run average cost curve.

In figure 11.4, it is shown that for producing level of output OQ_o. the corresponding point on the long run average cost curve LAC is C_o at which $SATC_1$ is tangent to the long run average cost curve. So, if the firm plans to produce OQ_o output, it will construct a plant corresponding to $SATC_1$ and will operate on this curve at point $C_{o.}$ If the firm plans to produce level of output OQ_1, correspondent to point C_1onthe long run average cost curve

LAC, $SATC_2$ is tangent to LAC at C_1. Similarly, we can explain points C_2 and C_3 at which OQ_2 and OQ_3 levels of output are planned to be produced respectively. Every point on the long run average cost curve is a tangency point with some short run average cost curve. The long run average cost curve LAC is also called 'envelope' curve since it envelops a set of short run average cost curves.

It can also be seen that larger levels of output can be produced at the lowest cost with the bigger sized plant, whereas smaller levels of output can be produced at the lowest cost with smaller sized plant.

Following observations can be easily made about the long run average cost curves.

1) Every point on the long run average cost curve is a tangency point with some short run average cost curve,
2) The long run average cost curve tangent to the minimum points of all the short run average cost curves,
3) The long run average cost curve is also U-shaped though it is much broader than short run average cost curve,
4) When the long run average cost curve is falling it is tangent to the short run average cost curve at a point left to the minimum point or is tangent to the falling portions of the short run cost curve,
5) When the long run average cost curve is rising, it will be tangent to the short run average cost curve at a point right to the minimum point or is tangent to rising portions of the short run average cost curve, and
6) When the long run average cost curve is a horizontal straight line, it will be tangent to the short run average cost curve at the minimum point of short run average cost curve.

11.5.2 Long Run Marginal Cost Curve

The long run average cost curve gives us the minimum unit cost of producing different levels of output. The long run marginal cost curve, on the other hand, shows the minimum amount by which cost is increased when output is increased or the maximum amount of total cost can be reduced when output is decreased. The relation between short run marginal cost and long run marginal cost is explained with the help of Figure 11.5.

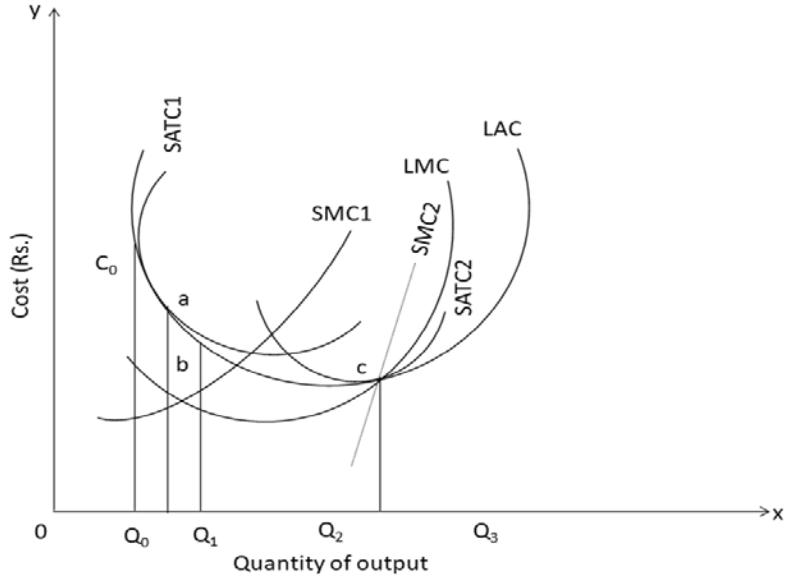

Figure 11.5 :Long Run Marginal Cost Curve

At OQ_o level of output $SATC_1$, and LAC are equal and, therefore, short run total cost is equal to long run total cost. At level of output OQ $SATC_1$, is more than LAC and therefore, short run total cost is greater than long run total cost. As level of output is expanded to $OQ_1$from OQ_1 long run marginal cost will be more than short run marginal cost.

The long run marginal cost curve intersects LAC when it is at its minimum point and there will be only one short run average cost curve ($SATC_2$ in Figure 11.5) which coincides with the long run average cost curve at its minimum point. At point C, $SATC_2$, is tangent to LAC and it is also the point at which $SATC_2$ and LAC are minimum. So, long run marginal cost equals short run marginal cost at point c. Hence, long run marginal cost curve passes through the minimum point on LAC. Joining the points like b and c will give long run marginal cost curve. Long run marginal cost curve will also be U-shaped and it will cut the long run average cost curve at its lowest point.

11.5.3 Why Long Run Average Cost Curve is U shaped?

The reasons for U-shaped short run average cost curves are already discussed in section 11.4.7. In unit 9, while explaining the law of increasing and diminishing returns to scale, the concepts of economies and diseconomies of scale were introduced. The same factors, namely, economies of scale (which explain increasing returns to scale) also explains why the long run average cost curve initially slopes downward with increase in the level of output. Similarly, the factors namely diseconomies of scale (which explains diminishing returns to scale) also explain why the long run average cost curve starts sloping upwards eventually with the increase in the level of output. It may be remembered that we have assumed that prices of factors are constant.

Q.1. Which of the following graphs is a correct description of the TFC curve?

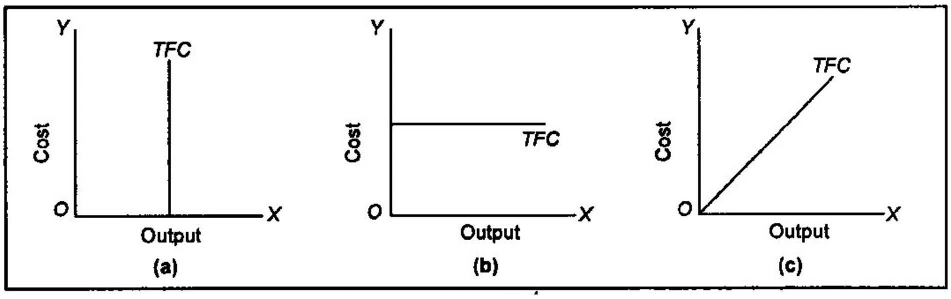

Fig. 1

Ans. Fig.1(b) is a correct description of the TFC curve. It always remains the same at all levels of output.

Q.2. Which of the following graphs represents the correct description of the TC curve?

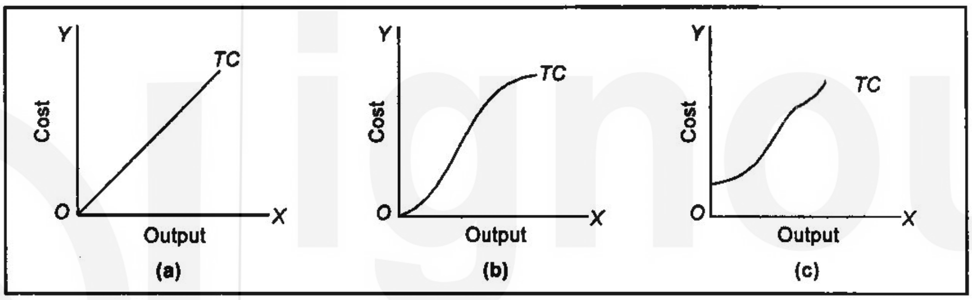

Fig. 2

Ans. Fig.2(c)

Q.3. Which of the following curves correctly represents the average fixed cost curve?

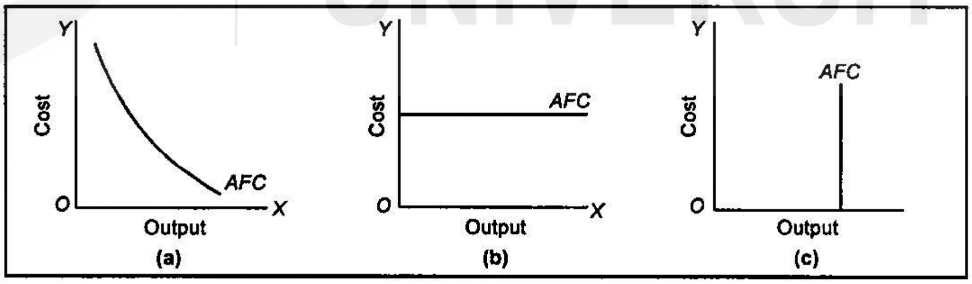

Fig. 3

Ans. Fig.3(a)

Q.4.Can AP curve be rising while MP curve is falling? Show graphically.

Ans. As shown in Fig. 4 the situation is reflected in the range R to S.

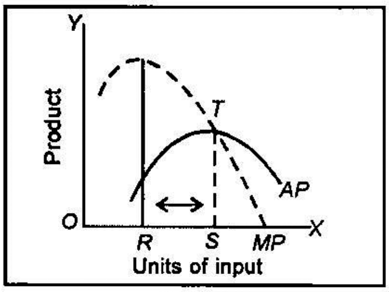

Fig. 4

Q.5.Assume that a production unit is subject to the law of diminishing returns right from the beginning, show graphically the relationship between AP and MP curves.

Ans. The relationship is depicted in Fig. 5 *MP* always lies below the AP curve. *MP* divides the distance between Y-axis and the *AP* curve in two equal parts.

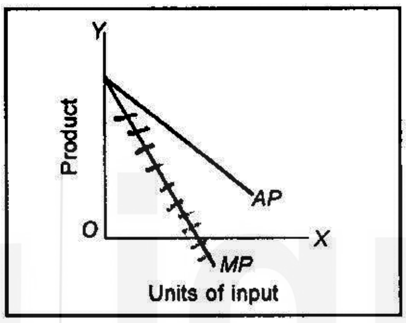

Fig. 5

Q.6.If production is subject to the law of variable proportions, will the total variable cost curve (TVC) be an upward rising straight line?

Ans. No. It would rise initially at decreasing rate and ultimately at an increasing rate, as shown in Fig.

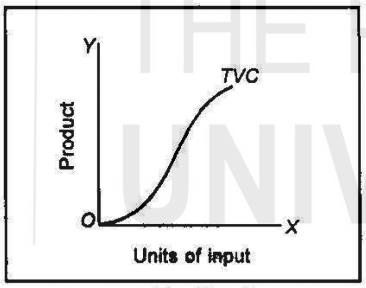

Fig. 6

Q.7.Does the total cost (TC) curve bear any relationship with the total variable cost curve?

Ans. Yes. TC curve rises along with the TVC curve, and always maintains equal distance to TVC curve. The distance represents the total fixed cost at different levels of output, as shown in Fig. 7

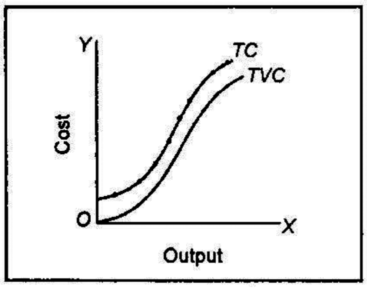

Fig. 7

Q.8. Which of the following figures is the correct description of the relationship between AVC and AC?

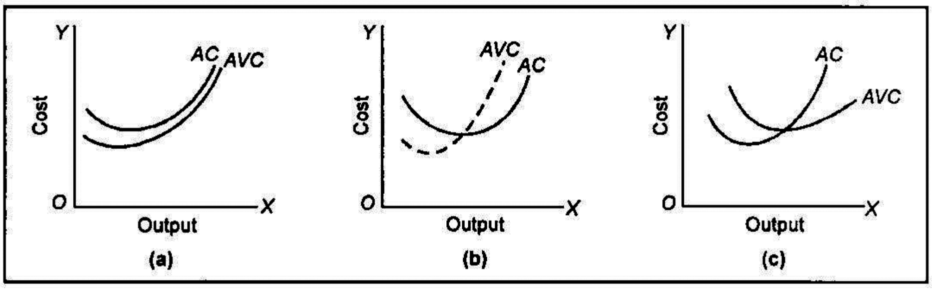

Fig. 8

Ans. Fig. 8 (a)

Q.9. Which of the following figures is the correct description of th»relationship between MC and AVC?

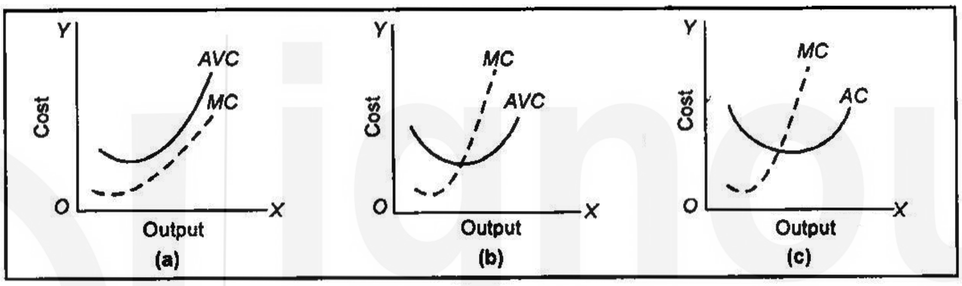

Fig. 9

Ans. Fig. 9 (b)

Q.10. Which of the following figures is the correct description of the relationship between AC and MCI?

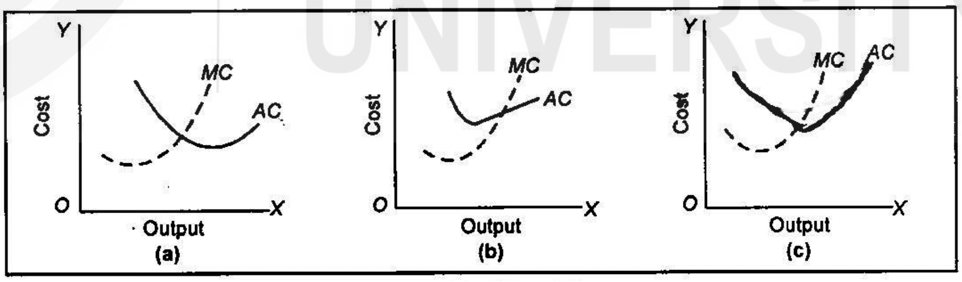

Fig. 10

Ans. Fig. 10 (c)

Q.11. Which of the following figures is the correct description of the relationship between MC and AC?

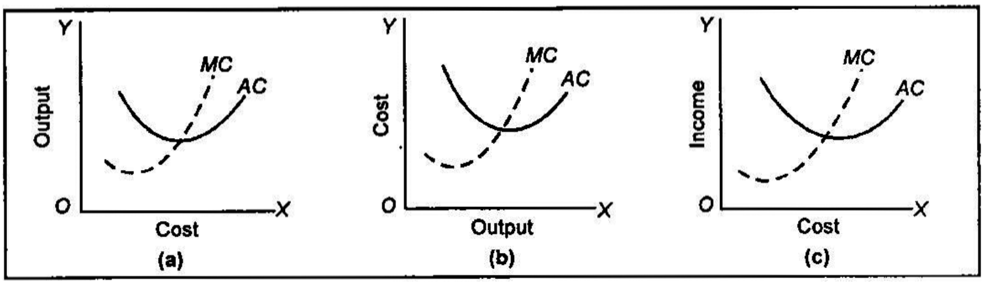

Fig. 11

Ans. Fig. 11 (b)

Q.12. Can MC be rising when AC is falling?

Ans. Yes. HT is the range in Fig.12

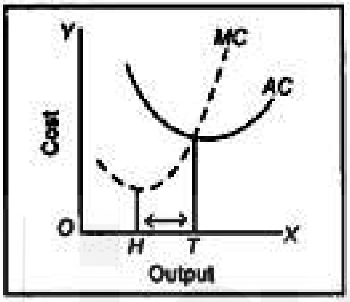

Fig. 12

Q.13. Can any short-run cost curve be a horizontal straight line? Show graphically.

Ans. Total fixed cost curve is always a horizontal straight line, as shown in Fig.13

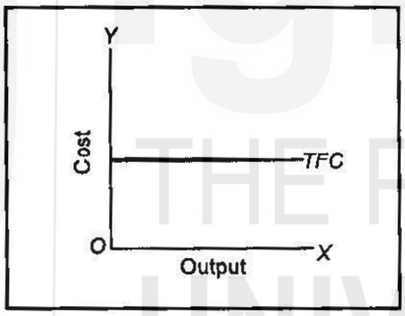

Fig. 13

Check Your Progress C

1) Distinguish between long run average cost and short run average cost.

2) State whether the following statements are **True** or **False.**

   i) Long run total cost is constant

   ii) Long run average cost curve is U-shaped

   iii) Long run average cost is the sum of short run average costs.

   iv) Long run marginal cost exceeds short run marginal cost for a decrease in output considering the point where short run average cost equals long run average cost.

   v) The factors which explain U-shaped short run average cost curve also explain U-shaped long run average cost curve.

   vi) Long run average cost curve is always tangent to the short run average cost curves at their minimum points.

vii) There is no relation between increasing returns to scale and decreasing long run average cost.

viii) Short run average cost curve is less broad U-shaped than long run average cost curve.

11.6 OTHER COSTS

There are some other Costconcept which are required to explain the behaviour of production.

These costs are as follows:

Accounting Costs

These are the costs which an accountant will take into account to find out the cost of production of a commodity or service. These costs consist of the payments and charges made by the entrepreneur to the suppliers of various productive factors like land, labour, capital and raw materials. So, the rent paid for the building hired by the firm, wages paid to the labourers employed, interest paid on the money or capital borrowed for doing business and prices paid for the raw materials, fuel and power used, together will constitute accounting costs. These costs involve payment by the entrepreneur of the firm. The accounting costs or payments which the firm makes to other factor-owners for purchasing or hiring the various factors are also referred to as **Explicit costs.**

Opportunity Costs

The concept of opportunity cost occupies an important place in modern economic analysis. The opportunity cost of producing any commodity, say, wheat is the amount of another commodity say rice, that must be sacrificed in order to use resources to produce wheat, rather than rice. To take another example, the factors which are used for the manufacture of steel frame of a cooler may also be used for the manufacture of steel buckets. Therefore, the opportunity cost of a steel frame of a cooler is the output of steel buckets sacrificed which could have been produced with the same amount of resources that have gone into the making of a steel frame of a cooler.

Two points must be kept in mind while defining opportunity cost.

(1) The opportunity cost of anything is only the next best alternative foregone. The opportunity cost of producing a commodity is not any other alternative commodity that could be produced, with the same factors; it is only the most valuable other good which the same factors could produce, and

(2) The opportunity cost of a good should be viewed as the next best alternative good that could be produced with the same amount of money (or the same money value of the factors).

This qualification of the same amount of money is required, to explain the concept of opportunity cost, because all the factors used in the production of one good may not be the same as are required for the production of the next best alternative good. For example, a farmer employs land, labour, water, fertilizers, wheat seed etc., for the production of wheat but to produce rice he may require the same factors except the type of seed. Similarly, a producing firm may shift from the production of one product to another without any changes in plant and equipment or its labour but it will require different types of raw materials. Thus, the equivalence of factors in money terms has to be taken to find out the opportunity cost of producing a commodity.

The resources of an economy are scarce and cannot be employed to produce all things simultaneously in sufficient quantity. Therefore, if they are used to produce one thing, they have to be withdrawn from other uses. So, the cost of the one thing is the alternative foregone.

The concept of opportunity cost has a wide application to economic problems. It is applicable to the determination of factor prices. It can also be applied to private consumption and public expenditure. For a student the cost of seeing a movie may be the book whose purchase is foregone by him. For the society, the cost of setting up a gun factory may be the parks and roads which are sacrificed. The opportunity cost also explains the phenomenon of price. Since, there is scarcity of factor services, they are put to alternative uses and the commodities produced with these resources command price. If they were in plenty, there would be no alternatives foregone, no opportunity cost and no price. They are priced because of their opportunity cost.

Some of the limitations of the concept of opportunity cost are as follows:

1. The concept of opportunity cost is not applicable to those factors which are fixed or specific. A specific or fixed factor is one which can be employed only to produce a. specific commodity and has no alternatives and hence its opportunity cost is zero.

2. The concept of opportunity cost assumes perfect mobility of factors. If factors are prevented from moving or are themselves reluctant to move to alternative occupations, then their prices do not reflect opportunity cost.

3. The foregone alternatives are often not clearly ascertainable. For example, a machine once installed has no alternative use and no opportunity cost.

These are some of the limitations of the concept of opportunity cost.

Private Costs

The production of a commodity can be looked from the point of view of an individual entrepreneur or a firm which is trying to maximise profits. **The costs taken into account to find out private profits are termed as private costs.** It includes both explicit and implicit costs. For example, an exporter to produce say 1,000 shirts, buys land, labour, capital and raw materials. Payment made for these constitute explicit cost. At the same time, he invests his time and money which if not invested in export business would have been invested where else. Thesecosts constitute implicit costs. If we add up explicit and implicit cost of producing 1,000 shirts we get private cost. The concept of private cost looks at cost from the point of view of a particular producer. Private profit may be pure economic private profit or accounting private profit.

The **pure economic private profits** earned by producing a given commodity may be thought of as accounting private profit minus what could be earned in the best alternative use of the time and money employed by the entrepreneur to produce this given commodity. Accounting private profit is equal to revenue earned by the producer by selling the commodity minus explicit costs.

Social Cost

It is a much broader concept as compared to private cost. The social cost is looked from the point of view of the society as a whole rather than an individual producing a commodity. Social cost is found out to get social profits rather than private profits. The production of a commodity or service generates some advantages or disadvantages to other members of the society. These advantages are available free of cost and, therefore, whosoever gets these advantages does not pay anything to the producer who has produced this commodity.

For example, a producer in order to facilitate easier movement of his raw materials and finished products may have constructed a road linking it with the highway. This linking road may be used by others also who will not compensate the producer for the benefit they are enjoying. Similarly, the production of commodity may cause discomfort to others and the producer will not compensate those to whom discomfort has been caused. An example of such discomfort is the smoke generated by a firm which is a cost to the society since people have to spend more on medicines and soap as smoke acts as a health hazard and at the same time the clothes of people get dirty earlier.

In the first case, when some people get an advantage without paying for it, private cost is more than social cost. On the other hand, in the second case when the production of a commodity causes disadvantage to others without compensating them, private cost is less than social cost. The difference between social cost and private cost arises because of externalities (positive or negative advantages available free of cost).

The social cost is the cost a society incurs when its resources are used to produce a given commodity. The concept of social cost is closely linked with opportunity cost.

The social cost of using given resources to produce a unit of any commodity 1 is the number of units of commodity 2 that must be sacrificed in the process, assuming given resources are used to produce both commodities 1 and 2. The social cost of producing say guns is not the money spent on purchasing factors of production and raw materials required to produce guns. The social cost of producing guns is the civilian goods like bread, butter, automobiles etc., which could have been produced by the resources employed to produce guns. The society must give up some of the civilian goods and services and this foregone production is the appropriate measure of the social cost of producing guns. It is in this sense, we say that social cost of producing a commodity is nothing but the opportunity cost.

Real Cost

This cost refers to payments which are made to factors of production to compensate for the toil and efforts in rendering their services. For example, real cost is computed in terms of the pain and the discomfort involved for labour when it is engaged in production. Similarly, the abstinence and sacrifice involved in saving and capital accumulation is the real cost of capital.

As a concept real cost should not be ignored but this does not carry much significance in the cost of production of a firm because it is a subjective concept and lacks precision. But to the extent payments for pain and discomfort to labour are wages and interest is paid for abstinence and sacrifice, real costs are incorporated in explicit costs. In reality, real costs seldom equal money expenses of production.

The different concepts of costs given in this section of the unit convey different meanings and each one is employed as a tool to analyse a particular economic problem. The concept of cost which is most important and more often employed by an economist is economic cost. It is concept of the economic cost which will be used to analyse the equilibrium of a firm under perfect competition, monopoly, monopolistic competition and oligopoly.

Check Your Progress D

1) Distinguish between private cost and social cost

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1) Classify the following into accounting cost, economic cost, opportunity cost and social cost.

Items

Classification

i) Salary paid to manager ..…………………………..

ii) Wastes of an industry thrown into the river

……………………………..

iii) The salary an entrepreneur could have earned by working as a manager in some other firm ……………………………..

iv) Cost of 10 units of commodity X in terms of 15 units of commodity Y

……………………………..

11.7 LET US SUM UP

Theory of costs of a producing firm relates total cost to the level of output. Physical conditions of production, price of factors of production and how far efficient use of inputs is made, together determine cost of production of a firm. There are a number of concepts of costs like, accounting costs, economic costs, opportunity costs, private costs, social costs and real costs.

In the short run, costs are divided into two categories, fixed and variable costs. Fixed costs do not vary with output. Variable costs are those which increase with rise in output and fall with reduction in output. Total fixed costs divided by output gives us average fixed cost. Similarly, total variable costs divided by output gives average variable cost.

Total fixed cost + Total Variable Cost = Total cost. Average fixed cost + Average variable cost = Average total cost. Marginal cost is the addition to total cost caused by the addition of one unit of output. Marginal cost is also defined as addition to total variable cost by the addition of one unit of output.

The gap between average total cost curve and average variable cost curve keeps falling with the increase in the level of output signifying that average fixed cost keeps falling with increase in the level of output. Average variable cost first falls, then becomes minimum and finally begins to rise with increase in output. Average total cost curve is normally U-shaped.

In the long run all the factors are variable. The long run average cost curve is derived from short run average cost curves. Different size plants are planned to be set up to achieve different levels of output in the long run. The long run average cost curve is also known as an 'Envelope' curve. Every point on the long run average cost curve is a tangency point with some short run average cost curve.

The long run marginal cost curve shows the minimum amount by which cost is increased when output is increased. It intersects long run average cost curve at its minimum point and there is only one short run average cost curve which coincides with minimum long run average cost.

The long run average cost curve is also U-shaped but it is much broader than short run average cost curve. The long run average cost curve slopes downward initially because of the existence of economies of scale and eventually it starts rising upwards because diseconomies of scale replace economics of scale.

11.8 KEY WORDS

Accounting Costs : The payments and charges made by the entrepreneur to the suppliers of various factors of production.

Average Fixed Cost: Total fixed cost divided by quantity produced.

Average Variable Cost: Total variable cost divided by quantity produced.

Average Total Cost : Total cost divided by quantity produced.

Diseconomies of Scale: The disadvantages in cost incurred by a firm when its own output or scale increases.

Economies of Scale : The advantages in cost enjoyed by a firm when its own output or scale increases.

Economic Costs : The accounting costs along with implicit costs consisting of the normal return on capital and the wages or salary the entrepreneur could have earned had he sold his services to others.

Fixed Cost: The cost incurred to employ fixed factors like machine, plant, etc.

Marginal Cost: It is the addition to total cost caused by the addition of one unit of output.

Opportunity Cost: The amount of another commodity that must be sacrificed in order to use resources released for the production of a given commodity.

Private Cost: The costs taken into account to find out private profits.

Real Cost: The payments which are made to factors of production to compensate for the toil and efforts in rendering their services.

Social Cost : The cost found out to arrive at social profits or the cost borne out by the society as a whole to produce a commodity or service.

Total Cost: The sum of total fixed cost and total variable cost.

Variable Cost: The cost incurred to employ variable factors like unskilled labour, raw material, etc.

11.9 ANSWERS TO CHECK YOUR PROGRESS

Check your progress A

3 i) Economic Costs ii) Zero iii) Explicit Costs + Implicit Costs, iv) Explicit v) Implicit Cost.

Check your progress B

2

TFC	TVC	TC	MC
100	--	100	--
100	40	140	40
100	70	170	30
100	120	220	50
100	180	280	60
100	250	350	70

3 i) False ii) False iii) True iv) False v) True vi) True vii) False viii) False ix) False x) True.

Check your progress C

2) i) False ii) True iii) False iv) True v) False vi) False vii) False, viii) True.

Check your progress D

2 i) Accounting Cost ii) Social Cost iii) Economic Cost, iv) Opportunity Cost.

11.10 TERMINAL QUESTIONS

1) Distinguish between the following:
   i) Fixed and Variable Cost.
   ii) Short run average cost and Long run average cost.
   iii) Average cost and Marginal cost.
   iv) Economic costs and Accounting cost.
   v) Explicit costs and Implicit costs.
   vi) Private cost and Social cost.
2) Define the concept of Marginal cost. What is the relation between average cost and marginal cost?
3) What is the relation between average cost and marginal cost? Use suitable diagrams.
4) Why is a short run average cost curve U-shaped?
5) Explain the shape of Average variable cost curve.
6) How is the Long run Average cost curve derived from Short run Average cost curves? Use suitable diagrams.
7) What is the relation between Short run marginal cost and Long run marginal cost?
8) Explain the factors responsible for Long run Average cost curve being U-shaped.

Note: These questions will help you to understand the unit better. Try to write answers for them. But do not submit your answers to the university for assessment. They are for your practice only.