Production possibility curve not only provides solutions for production problems, such as what to produce and how to produce, but can be used for various purposes. Some of its uses are as follows:

- Enables the planning authority of a developed nation to divert the usage of its resources for the production of necessary goods to the production of luxury goods and from consumer goods to producer's goods, after a certain point of time.
- Helps a democratic nation to focus and shift a major amount of resources in the production of public sector goods instead of private sector goods. The public sector goods are supplied and financed by government, such as public utilities, free education, and medical facilities. These goods are free or involve a negligible cost. On the other hand, private sector goods are manufactured by privately owned organizations and are purchased by individuals at a certain price.
- Helps in guiding the movement of resources from producer goods to capital goods, such as machines, which, in turn, increases the productive resources of a country for achieving a high production level.

7.5 Production Function

A function represents a relationship between two variables. For example, variable X and variable Y are related to each other in such a manner that a change in one variable brings a change in the other. The relationship between X and Y can be shown with the help of a formula, which is shown as follows:

$$Y=f(X)$$

In the aforementioned formula, the value of Y can be determined with the help of the given value of X. Similarly, production function is the mathematical representation of relationship between physical inputs and physical outputs of an organization. In other words, production function represents the maximum output that an organization can attain with the given combinations of factors of production (land, labor, capital, and enterprise) in a particular time period with the given technology. It acts as a collection of different production possibilities of an organization. Some of the popular definitions of production function are as follows:

In the words of ***Prof. Leftwitch****, "The term Production function is used to explain the physical relationship between the units of the factors of production of a firm (inputs) and the units of goods and services obtained per unit of time (outputs)."*

According to ***Citowiski****, "Production of a firm is the function of factors of production. If it is presented mathematically, it is called Production Function."*

According to ***Samuelson****, "Production Function is the technological relationship which explains the quantity of production that can be produced by a certain group of inputs. It is related with a given state of technological change."*

In the words of ***Watson****, "The relation between a firm's physical production (output) and the material factors of production (input) is referred to as production function."*

The relationship between input and output is represented in the form of table, graph, or equation. The input-output relationship is presented in a quantitative form. The long-run production function (Q) is usually expressed as follows:

$$Q= f(LB, L, K, M, T, t)$$

Where, LB= land and building

L = labor

K = capital

M = raw material

T = technology

t = time

However, the production function has reduced to capital and labor, so that it can be easily understood. A two variable production function can be expressed as follows:

$$Q= f(L, K)$$

Other factors are excluded from the production function due to various reasons. Land and building are excluded because they are constant for aggregate production function. However, in case of individual production function, they are included in capital factor. Raw materials are excluded because they represent a constant relationship with the output at all phases of production. For example, steel, tires, steering, and engines used for manufacturing cars explains a constant relationship with the number of cars. Similarly, time and technology are also constant over a period of time.

The algebraic or equation form of production function is most commonly used to analyze production. Let us understand the algebraic form of production function with the help of an example. Suppose a diamond mining organization has used two inputs capital and labor in the production of diamonds. Therefore, its production function can be expressed as under:

$$Q= f(L, K)$$

Where, L = labor

K = capital

This production function implies that quantity of diamond production depends on labor engaged in producing diamond and capital required to carry out production. The production of diamonds would increase with the increase in labor and capital. On the basis of time period required to increase production, an organization decides whether it should increase labor or capital or both.

An organization takes into account either long-run production or short-run production for increasing the level of production. In short-run, the supply of capital is inelastic (except for individual organization in perfect competition). This implies that capital is constant. In such a case, the organization only increases labor to increase the level of production. On the other hand, in the long-run, the organization can increase labor and capital both for increasing the level of production. Therefore, on the basis of time period, production function can be classified in two types, namely, short-run production function and long-run production function.

The short-run production function can be mathematically expressed as follows:

$Q = f(L, K)$

= constant

For example, if a production function is as follows:

$Q = bL$

In this case, b is the constant return to labor, which can be calculated as follows:

$b = \Delta Q/\Delta L$

On the other hand, the long-run production function can be algebraically represented as follows:

$Q = f(L, K)$

Let us convert the equation of production function into a table of production function with the help of Cobb-Douglas production function. The equation of Cobb-Douglas production function is as follows:

$Q = AK^aL^b$

Where, A, a, b = parameters

K = capital

L = labor

Q = maximum quantity of commodity

b = 1-a

For example, the values of parameters A, a, and b is 50, 0.5, and 0.5, respectively. In such a case, the production function can be expressed as follows:

$Q = 50K^{0.5}L^{0.5}$

This production function can be used to determine value of Q when the combination of K and L are different. The value of Q can be determined with the help of the following formula:

$Q = 50\sqrt{KL}$

Or,

$Q = 50\sqrt{K}\sqrt{L}$

Suppose, K = 2 and L = 5, then the value of Q is as follows:

$Q = 50\sqrt{2}\sqrt{5}$

$Q = 158$

Similarly, the value of Q can be determined for different values of K and L. These values can be represented in the form of a table that is known as tabular form of production function, which is shown in Table-2:

Table-2: Production Function

10	158	223	274	316	354	387	418	447	474	500
9	150	212	260	300	335	367	397	424	450	474
8	141	200	245	283	316	346	374	400	424	447
7	132	187	229	264	296	324	350	374	397	418
6	122	173	212	245	274	300	324	346	367	387
5	112	158	194	224	250	274	296	316	335	354
4	100	141	173	200	224	245	264	283	300	316
3	87	122	150	173	194	212	229	245	260	274
2	70	100	122	141	158	172	187	200	212	224
1	50	70	87	100	112	122	132	141	150	158
K/L	1	2	3	4	5	6	7	8	9	10

In Table-2, it can be seen that there are four combinations of K and L, which are yielding the same value of Q, 158. On joining these four combinations, a curve is drawn known as isoquant, which is discussed later in the chapter.

7.6 Short-Run Production Function

In the short run, production function is studied with one variable input, which is labor, while keeping other inputs constant. In other words, in the short run, change in production is brought by changing only one variable, others factors remain constant. Consequently, there would be a proportional change in the combination of factors of production. The proportional relationship between production and variable factor of production is called returns to factor.

With a change in proportional factors, there would also be a change in the level of total output. However, the total output changes at different rate. In the initial level, there is a sharp increase in the total output, when more units of a variable factor are employed on the fixed factor. After this, the total output increases at the constant rate. Ultimately, there is a decline in the total output. These phases are addressed in the law of diminishing returns.

Let us discuss the law of diminishing returns in detail in the next sections.

7.6.1 Law of Diminishing Returns

Law of diminishing returns explains that when more and more units of a variable input are employed on a given quantity of fixed inputs, the total output may initially increase at increasing rate and then at a constant rate, but it will eventually increase at diminishing rates. In other words, the total output initially increases with an increase in variable input at given quantity of fixed inputs, but it starts decreasing after a point of time. The law of diminishing returns is described by different economists in different ways, which are as follows:

According to ***G. Stigler****, "As equal increments of one input are added; the inputs of other productive services being held, constant, beyond a certain point the resulting increments of product will decrease, i.e., the marginal product will diminish."*

According to ***F. Benham****, "As the proportion of one factor in a combination of factors is increased, after a point, first the marginal and then the average product of that factor will diminish."*

In the words of ***Alfred Marshall****, "An increase in the Capital and Labour applied in the cultivation of land causes, in general, less than proportionate increase in the amount of produce raised unless it happens to coincide with an improvement in the art of agriculture."*

The assumptions made for the application of law of diminishing returns are as follows:

- Assumes labor as an only variable input, while capital is constant
- Assumes labor to be homogeneous
- Assumes that state of technology is given
- Assumes that input prices are given

Let us understand the law of diminishing returns with the help of an example. Suppose a mining organization has a machinery as the capital and mine workers as the labor in the short-run production. For increasing the level of production, it can hire more workers. In such a case, the production function of the organization would be as follows:

Q= f (L), K

Where K is constant

7.6.2 Significance of Law of Diminishing Returns

The law of diminishing returns can be applied in a number of practical situations. The law has implication in most of the productive activities, but cannot be applied in all productive activities. Therefore, it cannot be applied universally. The application of this law has been seen more in agricultural production rather than industrial production. This is because the inputs in agriculture production are natural, while in industrial production, inputs are generally manmade. Therefore, if increasing variable input is applied to fixed inputs, then the marginal returns start declining.

Law of diminishing returns helps mangers to determine the optimum labor required to produce maximum output. In addition, with the help of graph of law of diminishing returns, it becomes easy to analyze capital-labor ratio. If an organization falls in stage I of production, it implies that its capital is underutilized. Therefore, the organization needs to increase the number of workers. In case, the organization is in stage III, it implies that the organization needs to reduce number of workers. However, stage I and stage III are irrelevant for managers for setting the targets of output. Only stage II is used for this purpose because this stage provides information about the number of workers that need to be employed for reaching the maximum level of production. The decision regarding the employment of workers and setting the maximum level of output would only be possible when wage rate is known, which is discussed later in the chapter.

7.6.3 Optimal Employment of Labor

As shown in Table-3, when the number of workers is 20, then the output reaches to its maximum level. In such a case, an organization would prefer to hire 20 workers to meet the optimum level of output in case if the labor is available at free of cost, which is not possible. Hiring workers always incurs a cost for an organization in terms of payment of wages in exchange of services rendered by workers. Therefore, the number of workers employed depends on optimum output, product price, and wage rate. The maximum profit can be attained if marginal cost is equal to marginal revenue. In the present case, marginal cost would be equal to marginal wages that is MC=MW. In case of factor employment, the concept of Marginal Revenue Productivity (MRP) is used. MRP refers to the value of product obtained by multiplying the price of product and marginal product of labor. The following formula is used to calculate MRP:

$MRP = MP_L * P$

Let us understand MRP with the help of an example. Suppose the price of coal is Rs. 10. If Table-3 is considered, MP_L for the fifth worker is 229. In such case, MRP for the fifth worker can be calculated as follows:

$MRP = MP_L * P$

$MRP = 229 * 10$

MRP = Rs. 2290

Similarly, MRP can also be obtained for different workers. By considering Table-3, suppose the wage rate (equal to MRP) fixed by an organization is Rs.2900. In such a case, the organization would hire 7 workers because if it hires the 8th worker, then MRP would be Rs. 3010 (301*10). This would lead to a loss of Rs. 110 for the organization.

The MRP of different workers can be listed in a table and a graph can be formed from that table. By joining the MRP of different workers on the graph, a curve is obtained known as MRP curve. Figure-3 shows the MRP curve:

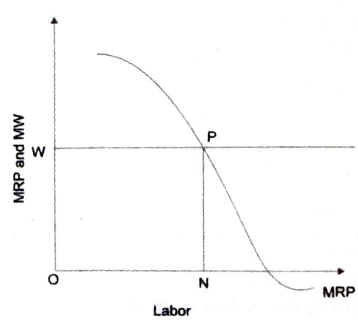

Figure-3: MRP Curve

This curve can be compared with MW curve. For example, in present case, wage rate is equal to OW. When wage rate becomes constant, then average wage is equal to marginal wage (AW = MW). The graph shows a horizontal straight line in case the wage rate become constant. The point at which MRP curve and straight line of AW= MW intersects is regarded as the optimal number of employees required to produce maximum profit.

7.7 Long-Run Production Function

In the previous sections, we have discussed production in the short run in which the functional relationship between input and output is explained assuming labor to be the only variable input, keeping capital constant. In the long run production function, the relationship between input and output is explained under the condition when both, labor and capital, are variable inputs. In the long run, the supply of both the inputs, labor and capital, is assumed to be elastic (changes frequently). Therefore, organizations can hire larger quantities of both the inputs. If larger quantities of both the inputs are employed, the level of production increases. In the long run, the functional relationship between changing scale of inputs and output is explained under laws of returns to scale. The laws of returns to scale can be explained with the help of isoquant technique, which is discussed in the next section.

7.7.1 Isoquant Curve

The relationships between changing input and output is studied in the laws of returns to scale, which is based on production function and isoquant curve. The term isoquant has been derived from a Greek work iso, which means equal. Isoquant curve is the locus of points showing different combinations of capital and labor, which can be employed to produce same output. It is also known as *equal product curve* or *production indifference curve*. Isoquant curve is almost similar to indifference curve. However, there are two dissimilarities between isoquant curve and indifference curve. Firstly, in the graphical representation, indifference curve takes into account two consumer goods, while isoquant curve uses two producer goods. Secondly, indifference curve measures the level of satisfaction, while isoquant curve measures output. Some of the popular definitions of isoquant curve are as follows:

According to **Ferguson**, *"An isoquant is a curve showing all possible combinations of inputs physically capable of producing a given level of output."*

According to **Peterson**, *"An isoquant curve may be defined as a curve showing the possible combinations of two variable factors that can be used to produce the same total product."*

From the aforementioned definitions, it can be concluded that the isoquant curve is generated by plotting different combinations of inputs on a graph. An isoquant curve provides the best combination of inputs at which the output is maximum.

Following are the assumptions of isoquant curve:

- Assumes that there are only two inputs, labor and capital, to produce a product
- Assumes that capital, labor, and good are divisible in nature
- Assumes that capital and labor are able to substitute each other at diminishing rates because they are not perfect substitutes
- Assumes that technology of production is known

On the basis of these assumptions, isoquant curve can be drawn with the help of different combinations of capital and labor. The combinations are made such that it does not affect the output. Figure-4 represents an isoquant curve for four combinations of capital and labor:

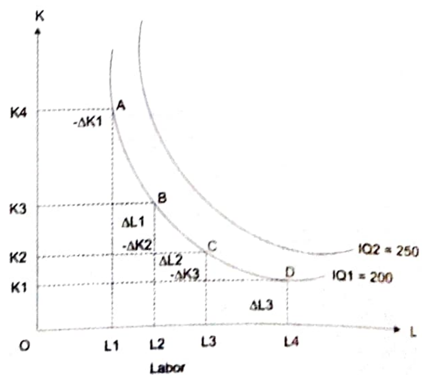

Figure-4: Isoquant Curve

In Figure-4, IQ1 is the output for four combinations of capital and labor. Figure-4 shows that all along the curve for IQ1 the quantity of output is same that is 200 with the changing combinations of capital and labor. The four combinations on the IQ1 curve are represented by points A, B, C, and D. Table-4 shows the relationship between input and output for IQ1 curve:

Table-4: Relationship between Input and Output in Isoquant Curve

Points	Input combinations			Output
	K	+	L	
A	OK4	+	OL1	200
B	OK3	+	OL2	200
C	OK2	+	OL3	200
D	OK1	+	OL4	200

In Table-4, as we move from A to D, capital starts decreasing with the increase in labor. This shows that capital is substituted by labor, while keeping the output unaffected.

As discussed earlier, isoquant curve is almost similar to indifference curve. The properties of isoquant curve can be explained in terms of input and output. Some of the properties of the isoquant curve are as follows:

- **Negative Slope**: Implies that the slope of isoquant curve is negative. This is because when capital (K) is increased, the quantity of labor (L) is reduced or vice versa, to keep the same level of output. As shown in Table-4, when the quantity of labor is increased from one unit to two units, the quantity of capital is decreased from four to three, to keep the level of output constant, which is 200.
- **Convex to Origin**: Shows the substitution of inputs and diminishing marginal rate of technical substitution (which is discussed later) in economic region. This implies that marginal significance of one input (capital) in terms of another input (labor) diminishes along with the isoquant curve. For example, in Table-4, it can be seen when more and more units of capital are used to produce 200 units of output, less or less units of labor are used.
- **Non-intersecting and Non-tangential**: Implies that two isoquant curves (as shown in Figure-4) cannot cut each other. Figure-5 shows the intersection of two isoquant curves:

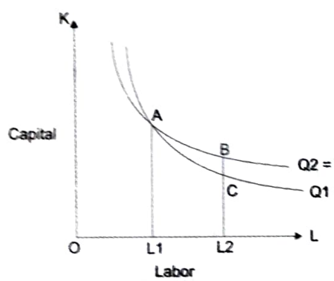

Figure-5: Intersecting Isoquant Curves

In Figure-5, the two isoquant curves intersect at point A. The point B on isoquant having Q2 = 300 and point C on isoquant curve having Q1 = 200 with the same amount of labor that is OL2. However, the capital is different that is BL2 in case of point B and CL2 in case of point C. A is the common point of isoquant for B and C points. Now, according to isoquant definition, the output produced at A is the same as produced on B and C points. On isoquant curve Q1, the output produced at A and C is 200 while on Q2 curve the output produced at A and B is 300. To make the input at point B and C equal, the following formula is used:

$$OL2 + BL2 = OL2 + CL2$$

$$BL2 = CL2$$

However, according to Figure-5, BL2 > CL2 but the intersection of two isoquants implies that BL2 and CL2 are equal with respect to their output, which is not possible. Therefore, it is stated that isoquant curves cannot intersect; otherwise the law of production would not be appiicable.

- **Upper isoquant have high output**: Implies that upper curve of the isoquant curve produces more output than the curve beneath. This is because of the larger combination of input result in a larger output as compared to the curve that is beneath it. For example, in Figure-5 the value of capital at point B is greater than the capital at point C. Therefore, the output of curve Q2 is greater than the output of Q1.

7.7.2 Marginal Rate of Technical Substitution

Marginal Rate of Technical Substitution (MRTS) is the quantity of one input (capital) that is reduced to increase the quantity of the other input (L), so that the output remains constant. Table-5 shows the marginal rate of technical substitution:

Table-5: MRTS of L for K

Combination	Input L	Input K	Output	MRTS of L for K
P	1	15	150	
Q	2	11	150	4:1
R	3	8	150	3:1
S	4	6	150	2:1
T	5	5	150	1:1

Table-5 shows that how much labor is required to replace one unit of capital while keeping the output same for all combinations of capital and labor, which is 150. In such a case, MRTS can be calculated with the help of the following formula:

$MRTS = \Delta K/\Delta L$

Where, ΔK = Change in Capital

ΔL= Change in Labor

For example, in Table-5 at point Q, MRTS can be calculated as follows:

ΔK = new capital – old capital

$\Delta K = 15\text{-}11$

$\Delta K = 4$

$\Delta L = 2\text{-}1$

$\Delta L = 1$

Therefore, MRTS at point Q would be:

$MRTS = \Delta K/\Delta L$

$MRTS = 4/1$ or 4:1

Similarly, we can calculate MRTS at different points, which are R, S, and T. Figure-6 shows the curve of MRTS:

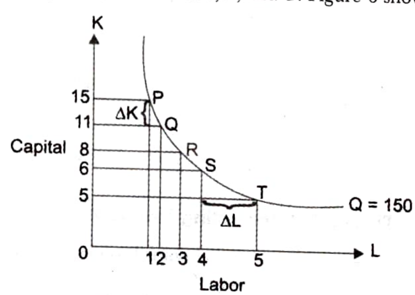

Figure-6: Curve of MRTS

7.7.3 Forms of Isoquants

The shape of an isoquant depends on the degree to which one input can be substituted by the other. Convex isoquant represents that there is a continuous substitution of one input variable by the other input variable at a diminishing rate. However, in economics, there are other forms of isoquants, which are as follows:

- **Linear Isoquant:** Refers to a straight line isoquant. Linear isoquant represents a perfect substitutability between the inputs, capital and labor, of the production function. It implies that a product can be produced by using either capital or labor or using both, if capital and labor are perfect substitutes of each other. Therefore, in a linear isoquant, MRTS between inputs remains constant. The algebraic form of production function in case of linear isoquant is as follows:

  $Q = aK + BL$

  Here, Q is the weighted sum of K and L. Slope of curve can be calculated with the help of following formula:

  $MP_K = \Delta Q/\Delta K = a$

  $MP_L = \Delta Q/\Delta L = b$

  $MRTS = MP_L / MP_K$

  $MRTS = -b/a$

- **Labor:** Acts as an important part of production. An organization requires labor to convert raw materials into finished goods. Labor cost is the main element of cost. Labor can be of two types, which are discussed as follows:
  - ⇨ **Direct Labor:** Refers to labor that takes an active part in manufacturing a product. This type of labor is also known as process labor, productive labor, or operating labor. The costs related to direct labor are called direct labor costs. These costs vary directly with the change in the level of output, thus it is referred as a variable expense.
  - ⇨ **Indirect Labor:** Refers to labor that is not directly related to the manufacturing of a product. The indirect labor cost may or may not vary with the change in the volume of output. This type of labor is used in the factory, office, and selling and distribution department.
- **Expenses:** Refer to costs that are incurred in the production of finished goods other than material costs and labor costs. Expenses are further divided into two parts:
  - ⇨ **Direct Expenses:** Imply the expenses that are directly or easily allocated to a particular cost center or cost units. These expenses are called chargeable expenses. Some of the direct expenses of an organization include acquiring machinery for special processes, fees paid to architects and consultants, and costs of patents and royalties.
  - ⇨ **Indirect Expenses:** Refer to expenses that cannot be allocated to specific cost center or cost units. For example, rent, depreciation, insurance, and taxes of building.

8.3 Kinds of Costs

The main aim of every organization is to earn maximum profit, which depends on costs incurred by an organization for different activities. There are different types of costs that are relevant to business operations and decisions. It is essential for organizations to have a clear idea about each costs incurred during production. This is because the price at which an organization is willing to supply depends on the costs of production. The costs are broadly grouped into two categories, namely, accounting cost and analytical cost, which are important for business operations and decisions. These two types of costs are shown in Figure-2:

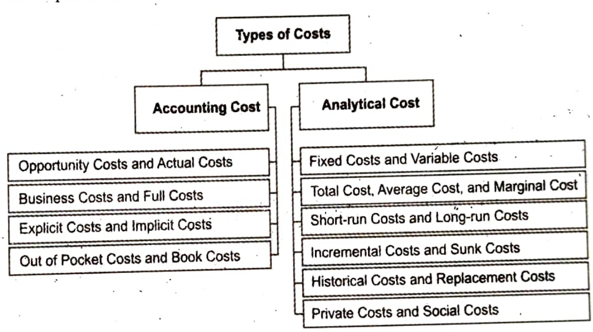

Figure-2: Different Kinds of Costs

The different types of costs (as shown in Figure-2) are explained in the next sections.

8.3.1 Accounting Cost

Accounting costs are also called as money costs or entrepreneur's costs. These are the expenses of an organization incurred during production and are entered in the books of accounts of the organization. In the words of Nicholson, *"Accounting cost refers to the out of pocket expenses, historical costs, depreciation, and other book keeping entries."* Out of pocket expenses are the costs that include immediate or instant payment to outsiders, which are discussed later in the chapter. Accounting costs are also known as actual cost or acquisition cost or absolute cost. These costs include the following:

- Wages to labor
- Interest on borrowed capital
- Rent paid to owners of the land
- Cost of raw materials
- Depreciation of capital goods

A producer should ensure that the price of the product should cover all these costs, so that production is continued. Accounting cost comprises a number of costs, which are discussed in detail in the next section.

Opportunity Costs and Actual Costs

The concept of opportunity cost marks a significant contribution in economic analysis. As discussed earlier, cost is considered as the value of inputs, such as land, labor, and capital, used for the production of goods and services. The inputs are always valuable for an organization as they are limited. If an organization utilizes an input to produce a particular good, then the same input would not be available to produce another good. The cost incurred on the next best alternative that is foregone to acquire or produce a particular good is known as opportunity cost. In other words, opportunity cost can be defined as the lost opportunity of not being able to produce some other product. Opportunity cost is also known as alternative cost or displacement cost or transfer cost. Some of the popular definitions of opportunity cost are as follows:

In the words of ***Leftwitch****, "Opportunity cost of a particular product is the sale of value of the foregone alternative product that resources used in its production, could have produced."*

According to ***Ferguson****, "the alternative or opportunity cost of producing one unit of commodity 'X' is the amount of commodity 'Y' that must be sacrificed in order to use resources to produce 'X' rather than 'Y'."*

Let us understand the concept of opportunity cost with the help of an example. Suppose an organization has Rs. 10, 000, 00 of which it has two alternative uses. It can either buy a machine for production of goods or invest it for the construction of canteen at the organization's premises. The annual expected income from using the machinery is Rs. 1, 50,000, whereas from canteen is Rs 1,00,000. A rational producer would opt for buying the machinery because it would yield high income for the organization than investing for canteen. Thus, opportunity cost for buying machinery is Rs 1, 00,000.

On the other hand, actual costs are those costs which are incurred by the organization on actual goods to carry out the production activities. These costs are incurred on purchasing raw materials, plant, machinery, and other physical assets. Actual costs are the payments that are made in monetary terms and are recorded in the books of accounts.

Business Costs and Full Costs

Business costs involve those costs that are incurred while carrying out business. These are also called real costs or actual costs. According to Watson, *"business costs include all the payments and contractual obligations made by the organization together with the book cost of depreciation on plant and equipment."* These costs are used for calculating business profits and losses and filing returns of income tax and other legal purposes. These costs include payment and contractual obligations made by the organization together with the cost of depreciation on plant and equipment.

On the other hand, full costs include actual costs, depreciation, implicit costs, and normal profits. Normal profits refer to minimum earnings in addition to the opportunity cost which an organization must receive to carry on production.

Explicit Costs and Implicit Costs

Explicit costs refer to the payments incurred by an organization in exchange of acquiring various resources, such as labor, material, plant, machinery, and technology. In other words, explicit costs can be defined as the payments incurred by organizations for outsiders who supply labor services, transport services, electricity, and raw materials. According to Leftwitch, *"explicit costs are those cash payments which firms make to outsiders for their services and goods."* Explicit costs are recorded in the books of accounts of an organization. Apart from this, there are certain costs that are neither converted into cash outlays nor added in the accounting system. Such costs are termed as implicit costs or imputed costs. These costs are considered as the costs of organization's self-owned resources. Opportunity cost is the important example of implicit costs. Let us understand the concept of implicit costs with the help of an example. Suppose Mr. X is carrying out his/her own business. He is also eligible to work as a manager in some organization at the pay package of Rs. 12, 00, 000 per annum. In such a case, he is foregoing his salary as a manager. This loss of salary would be an implicit cost for him from his own business. These costs are not taken into consideration, while calculating profit and loss of a business. However, these costs enable an organization to decide whether to select the available alternative or not.

Out of Pocket Costs and Book Costs

Out of pocket costs are those cash payments or cash transfers that are made for outsiders. These costs involve both recurring or non-recurring expenses. All the explicit costs, such as wages, rent, interest, transport expenditure, and salaries, are out of pocket costs. On the other hand, book costs refer to those costs that do not involve cash outlays, but are added in the accounting system. These costs are included in profit and loss accounts and are useful for getting tax benefits. For example, depreciation of machinery and unpaid interests are the book costs of an organization.

Both, out of pocket and book costs are important for calculating the total profit and loss of an organization. Generally, small-scale organization ignores book costs, which may lead to overestimation of profit.

8.3.2 Analytical Cost

Analytical costs are those costs that are taken into account for analyzing the production activities of an organization. These costs are the deciding criteria for carrying out business activities. For instance, if an organization is planning to expand, it needs to consider various costs, such as incremental costs, replacement costs, and fixed costs. In case the costs exceed the total budget of the organization, it may drop the idea of expansion. Apart from this, analytical costs are also helpful for making organizational decisions in different time periods. Let us discuss some of the analytical costs in detail in the next sections.

Fixed Costs and Variable Costs

Fixed costs refer to those that remain constant for a certain amount of output. The fixed costs include costs incurred on managerial and administrative staff, depreciation of machinery, and maintenance of lands and buildings. These costs are incurred in the short-run. On the other hand, variable costs are those costs that differ according to changes in the quantity of output. These costs include costs incurred on raw materials, transportation, and labor.

Total Cost, Average Cost, and Marginal Cost

Total cost refers to the total sum of the cost incurred on production of goods or services. It involves all implicit and explicit costs as well as fixed and variable costs incurred on acquiring resources for the production of goods or services. On the other hand, average cost is the total cost of production per unit of output. It is not considered as actual costs and is statistical in nature. Average cost can be calculated as follows:

Average Cost = Total Cost/ Output

Marginal cost is the addition to the total cost for producing an additional unit of the product. Some of the definitions of marginal costs given by different economists are as follows:

According to ***Mc Conell****, "marginal cost may be defined as the additional cost of producing one more unit of output."*

In the words of ***Ferguson****, "marginal cost is the addition to total cost due to the addition of one unit of output."*

Marginal cost can be calculated as follows:

$MC = TC_n - TC_{n-1}$

n= Number of units produced

MC is the rate of change of the total cost. It is also calculated as:

$MC = \Delta TC / \Delta Output$

Total, average, marginal costs play an important role in analyzing the production activities of an organization. These cost concepts are discussed later in the chapter.

Short-run and Long-run Costs

Short run refers to a period in which organization can change its output by changing only variable factors, such as labor and capital. In this period, the fixed factors, such as land and machinery, remain the same. The expansion is done by hiring more labor and purchasing more raw materials. The existing size of the plant or building cannot be increased in case of the short run. In context of costs, short run costs are those costs that have short-term application in the production process of an organization. Short-run costs involve costs incurred on raw materials and payment of wages. Short-run costs change with the change in the level of output.

On the other hand, long run refers to a period in which all the factors are variable. The existing size of the plant or building can be increased in case of the long run. Long run costs vary with variation in the size of manufacturing plant or organization. Long-run costs include costs incurred on plant, building, and machinery.

Incremental Costs and Sunk Costs

Incremental costs are those costs that are incurred during the expansion of an organization. These are the added costs that are involved in changing the level of production or the nature of business activity. Expansion can be in the form of men, materials, and machinery. Incremental costs are incurred by an organization for various purposes, such as purchasing new machines, changing distribution channel, and launching a new product. For instance, if an organization purchases machinery, then following incremental costs are incurred:

- Cost of purchase
- Maintenance charges
- Installation charges
- Operational charges

On the other hand, sunk costs are those costs that are incurred whether there is an expansion or not. These are the costs which are made once and cannot be altered, increased, or decreased. These types of costs are based on the prior commitment; thus, cannot be revised or recovered. For instance, if an organization hires a machine; it has to bear the rent and other operational charges, which are the sunk costs of the organization.

Historical and Replacement Costs

Historical costs are those costs that are incurred in the past by an organization for acquiring assets, such as land, building, and machinery. These costs help in assessing the net worth of the organization. Historical costs reduce on an annual basis due to depreciated value of assets, such as machinery and equipment. On the contrary, historical cost increases in case of land, buildings, and metals, such as gold and silver.

On the other hand, replacement cost is incurred when an asset depreciates and is replaced with the new asset. Let us understand the concept of replacement costs with the help of an example. For instance, the historical cost of a machine is Rs. 85, 000, which was purchased by an organization two years ago. Now, the organization is willing to replace the existing machine with the new one. The current price of the machine in the market is Rs. 90, 000, which is a replacement cost.

Private and Social Costs

Private costs are those costs that are incurred for carrying out different business operations. In other words, these costs are added in the total cost of production of an organization. In the words of miller, "*private costs are those costs that are incurred by the firm or the individual producer as a result of their own decisions.*" All explicit and implicit costs fall into the category of private costs.

On the contrary, social costs are those costs that are borne by the society and are not explicitly paid by the organization. Such costs include pollution (air, water, and noise) and global warming, which take place due to production activities of an organization. According to Dictionary of Modern Economics, "*social costs of a given output is defined as the sum of money which is just adequate when paid as compensation to restore to their original utility levels all who lose as a result of the production of the output.*"

8.4 Different Types of Costs in the Short Run

Conceptually, in the short run, the quantity of at least one input is fixed and the quantities of the other inputs can be varied. In the short-run period, factors, such as land and machinery, remain the same. On the other hand, factors, such as labor and capital, vary with time. In the short run, the expansion is done by hiring more labor and increasing capital. The existing size of the plant or building cannot be increased in case of the short run. Following are the cost concepts that are taken into consideration in the short run.

- **Total Fixed Costs (TFC):** Refer to the costs that remain fixed in the short period. These costs do not change with the change in the level of output. For example, rents, interest, and salaries. In the words of Ferguson, "*Total fixed cost is the sum of the short run explicit fixed costs and implicit costs incurred by the entrepreneur.*" Fixed costs have implication even when the production of an organization is zero. These costs are also called supplementary costs, indirect costs, overhead costs, historical costs, and unavoidable costs.

  TFC remains constant with respect to change in the level of output. Therefore, the slope of TFC curve is a horizontal straight line. Figure-3 depicts the TFC curve:

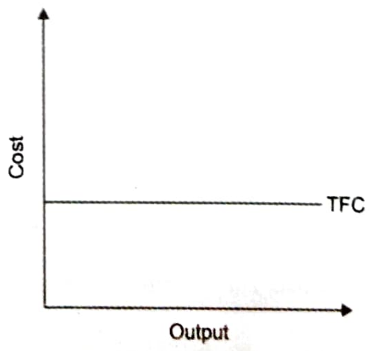

Figure-3: TFC Curve

  As shown in Figure-3, TFC curve is horizontal to x- axis. From Figure-3, it can be seen that TFC remains the same at all the levels with respect to change in the level of output.

- **Total Variable Costs (TVC):** Refer to costs that change with the change in the level of production. For example, costs incurred on purchasing raw material, hiring labor, and using electricity. According to Ferguson, "*total variable cost is the sum of amounts spent for each of the variable inputs used.*" If the output is zero, then the variable cost is also zero. These costs are also called prime costs, direct costs, and avoidable costs. Figure-4 shows the TVC curve:

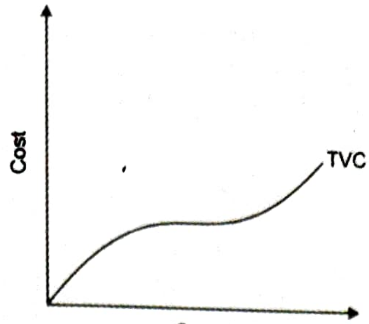

Figure-4: TVC Curve

In Figure-4, it can be seen that TVC curve changes with the change in the level of output.

- **Total Cost (TC):** Involves the sum of TFC and TVC. It can be calculated as follows:

  Total Cost= TFC+TVC

TC also changes with the changes in the level of output as there is a change in TVC. Figure-5 shows the total cost curve derived from sum of TVC and TFC:

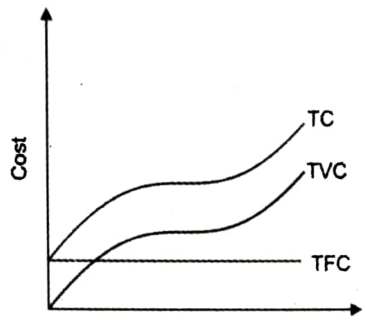

Figure-5: TC Curve

It should be noted that both TVC and TC increase initially at decreasing rate and then they increase at increasing rate. Here, decreasing rate implies that the rate at which cost increases with respect to output is less, whereas increasing rate implies the rate at which cost increases with respect to output is more.

- **Average Fixed Costs (AFC):** Refers to the per unit fixed costs of production. In other words, AFC implies fixed cost of production divided by the quantity of output produced. It is calculated as:

  AFC= TFC/Output

As discussed earlier, TFC is constant as production increases, thus AFC falls. Figure-6 shows the AFC curve:

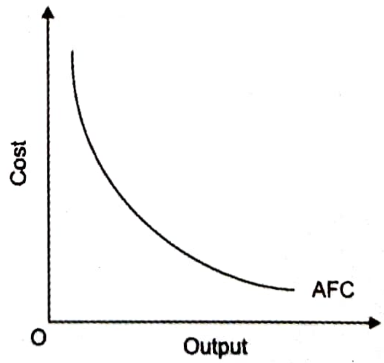

Figure-6: AFC Curve

In Figure-6, AFC curve is shown as a declining curve, which never touches the horizontal axis. This is because fixed cost can never be zero. The curve is also called rectangular hyperbola, which represents that total fixed costs remain same at all the levels.

- **Average Variable Costs (AVC):** Refer to the per unit variable cost of production. It implies organization's variable costs divided by the quantity of output produced. It is calculated as:

  AVC= TVC/ Output

Initially, AVC decreases as output increases. After a certain point of time, AVC increases with respect to increase in output. Thus, it is a U- shaped curve, as shown in Figure-7:

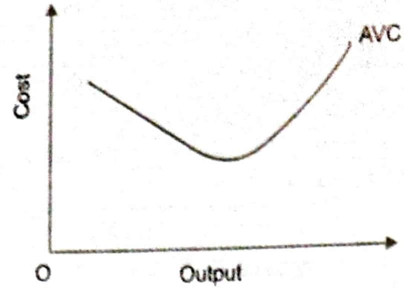

Figure -7: AVC Curve

- **Average Cost (AC):** Refer to the total costs of production per unit of output. AC is calculated as:

  AC=TC/ Output

  AC is also equal to the sum total of AFC and AVC. AC curve is also U-shaped curve as average cost initially decreases when output increases and then increases when output increases. Figure-8 shows the AC curve:

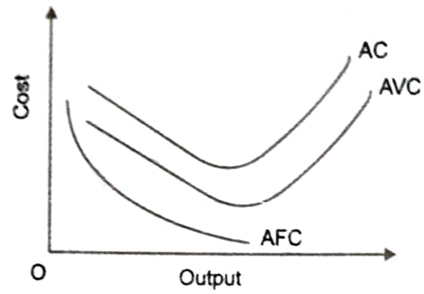

Figure -8: AC Curve

EXHIBIT-1

Reason for U-shape of Short Run Average Cost Curves

Average costs curves are the sum of AFC and AVC. As output increases, TFC remains fixed, thus, AFC declines. AVC also declines as output increases. Thus, as AC equals AFC+AVC, AC also declines as output increases. AVC increases steeply after reaching minimum and this increase in AVC is more than the fall in AFC. After that, AC starts rising as output increases. Thus, AC curve is U-shaped curve.

- **Marginal Cost:** Refer to the addition to the total cost for producing an additional unit of the product. Marginal cost is calculated as:

  $MC = TC_n - TC_{n-1}$

  n= Number of units produced

  It is also calculated as:

  $MC = \Delta TC / \Delta Output$

  MC curve is also a U-shaped curve as marginal cost initially decreases as output increases and afterwards, rises as output increases. This is because TC increases at decreasing rate and then increases at increasing rate. Figure- 9 shows the MC curve:

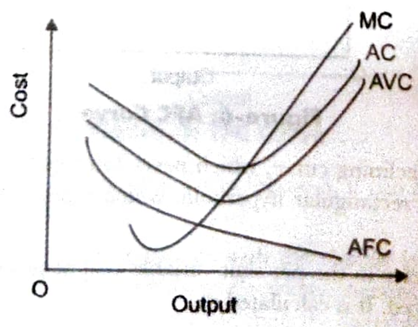

Figure-9: MC Curve