

Productivity : Concept and Measurement

Learning Objectives

After studying this chapter, you should be able to

- Explain the factors of production
- Define productivity and related concepts
- Explain the formulae for measuring productivity of resources
- State the relationship between productivity, efficiency and profitability
- Explain the importance of productivity
- Describe the factors affecting productivity
- Highlight the steps for increasing industrial productivity

Production is the transformation of inputs into the output of a commodity in a specific period of time with the given technology. But the term 'production' in economics is not simply confined to effecting physical transformation of inputs; it covers rendering of services such as transporting, financing, trading, packaging, etc. In a broad sense, production implies the creation of form, place and time utilities of different usable commodities and services.

3.1 FACTORS OF PRODUCTION

Production process may use several inputs. Each distinct input into the production process can be regarded as a factor of production. For example, for the production of garments, piece of land is required to build a factory where the production takes place. It also requires the services of labour. Capital is required to meet capital expenditure on the purchase of machines, tools, etc. and for incurring operating expenditure on raw materials, power etc. Finally, the services of entrepreneur are required to organise, supervise and coordinate the whole process of production including the inputs of land, labour and capital. These are the primary inputs in the sense that they participate in the production activity in the first instance.

3.1.1 Land

According to Marshall, the term 'land' means "the whole of the materials and forces which nature gives freely for man's aid in land and water, in air, light and heat". Thus, the term land is used in a broader sense to include all resources which are free gift of nature and which could be used for the production of goods and services to satisfy human wants. It does not simply refer to land in the ordinary sense of the term, but also resources like forests, lakes, seas, waterfalls, rainfall, mountains, climate, weather, sunshine, minerals, air, etc. Land includes not only the land used for agricultural or industrial purposes, but also all the natural resources taken from above or below the soil. Thus, land represents the sum total of natural resources available to the economy.

3.1.2 Productivity of Land

The power of a particular plot of land to produce something is called its productivity. Other things remaining the same, greater the amount of produce per acre, higher is the productivity. The following factors determine productivity of land :

- (i) Natural endowment.
- (ii) Human factors—knowledge, training and experience.
- (iii) Type of organisation of farm.
- (iv) Regional location of plot/farm.
- (v) Alternative uses.
- (vi) Availability of irrigation.
- (vii) Availability of capital.
- (viii) Techniques of agriculture.
- (ix) Mechanisation and automation, etc.

3.1.3 Labour

According to Marshall, "By labour is meant the economic work of man, whether with the hand or with the head." Thus, labour is any type of manual or mental activity with a view to earning a reward. The concept of labour is confined to human effort only and not the work performed by animals and machines.

In common parlance, labour stands for unskilled labour, but in economics, it stands for all kinds of labour which is used in the production of goods and services. It includes skilled and unskilled labour, manual (physical) and mental labour, technical and non-technical labour, ordinary and managerial labour, and those employed in education, hospitals, government, administration, justice, etc.

3.1.4 Factors Affecting Productivity of Labour

Productivity of labour is influenced by the following factors:

- (i) **Racial Qualities**: Racial blood of a worker is said to influence his efficiency. For instance, workers from Punjab and Haryana are more hard working and can do any type of physical work efficiently.
- (ii) **Education and Training**: The level of general education and particular training of a worker determines his efficiency. A technically trained worker can handle machines much more easily. His efficiency is higher.
- (iii) **Climate**: Climate has a decisive effect on worker's efficiency. Excessively hot climate reduces the working capacity and resistance of workers.
- (iv) **Level of Wages**: Level of wages is determined by efficiency of workers. Level of wages also affects efficiency. Higher wages increase the worker's standard of living and hence his efficiency.
- (v) **Standard of Living**: The standard of living enjoyed by a worker also affects his efficiency. If workers get good food and leisure, their physical power and mental capacity increase because they do not easily fall ill. Indian workers are less efficient mainly because of their low standard of living.
- (vi) **Managerial Ability**: Workers' productivity is influenced by the managerial ability of the organisation or entrepreneur. Proper division of work, creation of balanced jobs, placing right person on the right jobs, training of workers, etc. can help in achieving higher productivity of labour.
- (vii) **Type of Supervision**: If the supervision is strict and task oriented, the productivity of labour is going to be higher. However, if workers find jobs somewhere else, they would like to leave the organisation where strict supervision is exercised.
- (viii) **Hours of Work**: If a worker is working for long hours of work everyday, his productivity decreases because of deterioration of his health.
- (ix) **Working Conditions**: A worker's efficiency also depends on his working conditions. If the place of work is clean and ventilated, well-lighted the atmosphere is peaceful, and there are sitting arrangements for the workers, the worker's efficiency increases.
- (x) **Nature of Work**: If work is according to likings of a worker, he would be more efficient. The employers, who put workers on the jobs they like, get greater efficiency.

- (xi) **Miscellaneous Factors** : Productivity of workers may be higher under the following conditions :
- To have job security.
 - To earn promotion.
 - To satisfy one's innerself.

3.1.5 Capital

According to Marshall, "Capital consists of those kinds of wealth, other than free gifts of nature, which yield income". It is that part of wealth, which is used for further production of wealth. It appears in various forms like plant and machinery, tools, buildings, roads, dams, bridges, means of transportation and communication, etc. These capital goods have limited life. However, supply of capital is not fixed in short period. It can be varied. As capital is the result of human earning diverted to the production of goods and services meant for further production, instead of goods meant for consumption, there is no limit to which it can be accumulated. This process of addition of capital stock is called *capital formation*. Capital formation plays a vital role in the process of economic development of a country.

3.1.6 Entrepreneur

J.B. Say, a French economist, defined an entrepreneur as *an agent who unites all factors of production—land, labour, capital etc. and earns profits after making payments for these factors of production*. An entrepreneur assembles, coordinates and manages the means of production. Joseph Schumpeter, another economist, considers an entrepreneur as an innovator who carries out new combinations to initiate and accelerate the process of economic development.

According to F.H. Knight, "An entrepreneur is a person who performs dual function of risk-taking and control." Knight considered risk-taking to be the major function of the entrepreneur. This distinguishes him from other factors who take no risk by working on contract.

Entrepreneurship is the process of identifying opportunities in the market place, marshalling the resources required to pursue these opportunities and investing the resources to exploit the opportunities for long-term gain. It involves creating wealth by bringing together resources in new ways to start an enterprise that benefits the customers and the promoters both.

3.1.7 Role and Functions of Entrepreneur

The various roles performed by an entrepreneur are as under :

- Innovation** : An entrepreneur is basically an innovator who tries to develop new technology, products and markets. Innovation implies doing things in new ways or doing new things. It may involve introduction of new techniques, introduction of new goods and services, developing a new market, etc. The entrepreneur uses his creative faculties to do new things and exploit opportunities in the market. He does not believe in *status quo*, he wants change.

2. Bearer of Risks and Uncertainty : An entrepreneur assumes business risks and is prepared for the losses that may arise because of unforeseen contingencies in future. This willingness to take risks allows him to take initiatives in doing new things or trying new methods of production. This helps in satisfying their achievement need.

3. Promoter : Traditionally, an entrepreneur undertakes the risk of setting up a small enterprise as a sole proprietor. But these days, many entrepreneurs have assumed the role of promoters of large joint stock companies. As promoters, they conceive the business idea, conduct feasibility studies, take steps to get the company registered and raise capital for the company from the public and other sources. In such cases, the distinction between an entrepreneur and a promoter is of academic interest only. Thus, the persons who start a new business as sole proprietors of partnership firm are known as entrepreneurs. But those connected with the incorporation of a company are often known as 'promoters'. The promoters complete all legal formalities to get a company registered and also raise capital from the public.

4. Supplier of Capital : In several cases, entrepreneurs start business enterprises with their own financial resources. Thus, they supply initial capital to the business and undertake business risks. However, technocrat entrepreneurs approach financial institutions to raise 'risk capital' for their ventures or enter into partnership with those who can contribute capital to the business.

5. Management : In most of the cases, small entrepreneurs also assume the managerial role. As a manager, the entrepreneur plans, organises, directs and controls the activities of the business. He leads the workers, coordinates their operations and motivates them for higher productivity. However, when the size of business grows considerably, the entrepreneur can employ professional managers for effective management of the business.

3.1.8 Qualities of an Entrepreneur

The success of any business depends on the efficiency of the entrepreneur, that is, the capacity to produce maximum at the minimum cost. Following are the requisite qualities of an efficient entrepreneur.

1. Foresightedness : Business is full of risks and uncertainties. In order to cope with various kinds of risks and uncertainties efficiently, the entrepreneur should be intelligent and have foresightedness to make good forecasts for the business. The quality of forecasting will determine the quality of business planning. All other actions of the businessman will be futile if his planning lacks imagination and foresightedness. Thus, the entrepreneur must have the ability to perceive threats and opportunities in the environment.

2. Open Mind : The entrepreneur must have an open mind. He must possess a dynamic outlook so that he is quick in taking decisions on various problems of the business. He must always be prepared to take initiative whenever an opportunity arises. The ability of the businessman to take initiative influences the success of the business to a great extent.

3. Adaptability : The entrepreneur knows how to change with the changed circumstances. He can adapt himself to the new environment. He does not put resistance to changes. He always keeps an eye on new developments in technology and marketing.

4. Self Confidence : The entrepreneur should not lose confidence in difficult situations like labour troubles, legal disputes, depressions, stiff competition, government policy, power breakdown, etc. He should rather face such situations boldly and with confidence.

5. Knowledge of Business : He should be familiar with the intricacies of the business and psychology of the workers to handle the situation properly and establish industrial peace.

6. Innovative Attitude : A businessman should have aptitude for innovation and research for the benefit of the society. He should increase the utility of his products from the point of view of the society. He should help the people to derive greater utility from his products.

7. Leadership Qualities : An entrepreneur must possess the minimum qualities required of a good leader. He should have self discipline, presence of mind, sense of justice, honour and dignity, and above all a high moral character. He should have constructive imagination and ability to take quick decisions.

8. Dependability : The behaviour of the entrepreneur should be consistent. He should take firm decisions based on sound principles. He should create confidence among workers, suppliers and consumers. If a businessman is dependable, the various groups of the society dealing with him will cooperate with him in expanding the scale of operations of his business.

3.2 PRODUCTIVITY AND RELATED CONCEPTS

Productivity measures the efficiency of the production system. The efficiency with which resources are utilised is called productive efficiency. Higher productivity means producing more from a given amount of inputs or producing a given amount with lesser inputs. At the level of a plant or an industry, productivity is an output-input ratio. But at the macro level, productivity is a measure of performance of an economy. From a nation's viewpoint, productivity is the ratio of available goods and services to the potential resources of the country.

3.2.1 Concept of Productivity

In a broad sense, the term 'productivity' represents goods and services produced in relation to the resources utilised in their production. It may be defined as the ratio of output to input. Higher productivity means efficient use of inputs and vice versa. According to Peter Drucker, productivity represents the balance between all factors of production that will give the greater output at the smallest effort. In technical terms, productivity may be defined as the relationship between output and input.

$$\text{Productivity} = \frac{\text{Output}}{\text{Input}}$$

whereas output means goods and services produced and input represents capital, labour, materials, machines, energy, management, etc.

Productivity is the measure of how well the resources are brought together in an organisation and utilised for accomplishing a set of objectives. In the measurement of productivity, there are two variables :

- (1) Quantity of production (output).
- (2) Quantity of resources (input).

Productivity varies with the quantum of production and the amount of resources used. Productivity can be increased in various ways like :

- (i) By increasing production using same amount of resources.
- (ii) By reducing the amount of resources, while keeping the same production.
- (iii) By keeping the rate of increase of output more as compared to the rate of increase in input.

According to the International Labour Office, "The ratio between output and one of the factors of input is generally known as productivity of the factor considered." Thus, productivity means the ratio between output and any of the factors of production, say, labour, machines, capital, materials, land, etc.

Generally, the term 'productivity' is used synonymously with the productivity of labour. The International Labour Organisation opined that in as much as interest most often centred around the relationship of production and labour, the term 'productivity' always refers to output to the corresponding input of labour. Though there is a difficulty in arriving at the homogeneity concerning labour due to difference in scale, energy, training, environment, incentive, rates of pay, etc., this ratio of output to input of labour is universally acknowledged to have some uniformity, subject to the limitations mentioned and probable adjustments in actual working out of the productivity in quantitative terms.

The above definition is criticized on the ground that it does not take into consideration all the factors of production, though all of them have combined influence on total production or output. Nonetheless, labour is selected as the unit of input factor for the following reasons:

- (i) Labour force is one of the most important resources.
- (ii) Labour time is more readily measurable than other input factors, and it is used in almost all the industries.
- (iii) Productivity of labour has an influence on the cost of production and standard of living.
- (iv) All the other factors of production are subject to law of mechanics, i.e., their output is increased in a more or less fixed proportion to their input.

3.2.2 Production and Productivity

The difference between production and productivity should be noted carefully. Production refers to the quantity or value of output of a particular goods or service

produced in a given period of time by using a specified amount of inputs. Unlike production which is an absolute measure, productivity, typically expressed as a ratio, is a relative measure and refers to the efficiency with which the inputs have been utilised to obtain a given output. It is important to remember that rising productivity does not necessarily reflect an increase in production. The productivity ratio may show a rise as both output and input increase and as both output and input fall.

For example, if the output of a commodity increased from 10,000 units in 2001 to 15,000 in 2002 and the man-hours used from 2,000 to 2,500, then the productivity (ratio) increased from 5 to 6, i.e., a rise of 20% from 2001 to 2002. Now suppose that the output of another commodity recorded a decline from 10,000 units in 2001 to 9,000 units in 2002 and the man-hours for the same period decreased from 5 in 2001 to 6 in 2002, thus recording an increase of 20% despite fall in output. Similarly, all increases in output do not necessarily result in increased productivity. Thus if increase in output is lower than the proportional increase in resources employed to obtain it, the productivity ratio will show a decline despite higher output. Hence, there is need for caution in interpreting data on productivity.

3.2.3 Productivity, Efficiency and Profitability

Productivity represents the ratio between output and input. There are two broadways of improving upon the level of productivity : (a) increasing the output with the same amount of input, and (b) reducing the inputs for the existing level of output. In the first case, better utilisation of resources will help in improving the level of productivity, while in the second, economy in the use of resources will increase productivity. When higher productivity is the outcome of better utilisation of resources, this is referred to as 'increase in efficiency'. And when saving and conservation of resources result in higher productivity, this is described by the term 'economy'.

Another relevant concept for a business manager is profitability. It is widely known that profitability depends to a great extent on productivity. Other things being equal, an increase in productivity leads to higher profitability. However, productivity is a necessary, but not a sufficient condition for increase in sales prices, profitability will decline despite improvement in productivity.

3.3 MEASURING PRODUCTIVITY OF RESOURCES

Productivity is defined as the ratio of output to input. Symbolically,

$$\text{Productivity} = \frac{\text{Output}}{\text{Input}} \quad \text{or} \quad P = \frac{O}{I}$$

Theoretically, it is possible to measure the productivity of each input factor like labour, capital, machine, materials, etc., separately, or of all input factors combined. In practice, however, productivity of labour and capital is usually measured. Further, productivity may be measured in terms of physical units or

monetary units, depending upon the availability of data and the requirements of specific situations.

(i) **Productivity of Labour**: Productivity of labour is the ratio between output and labour input in the form of number of workers or man-house work. Symbolically, it can be expressed as :

$$\text{Productivity of Labour} = \frac{\text{Output}}{\text{Number of Workers or Number of Man-hours}}$$

~~Man-hours = No. of workers employed × No. of hours worked~~

Labour productivity so computed reflects the magnitude of output per unit of labour input.

(ii) **Productivity of Capital** : Productivity of capital is the ratio between output, measured in money value, and amount of capital employed. It can be expressed as :

$$\text{Productivity of Capital} = \frac{\text{Output}}{\text{Capital Employed}}$$

(iii) **Productivity of Other Factors** : It is possible to compute the productivity of other factors of production :

$$(a) \text{Productivity of Materials} = \frac{\text{Output}}{\text{Materials}}$$

$$(b) \text{Productivity of Machine} = \frac{\text{Output}}{\text{Machine-hours worked}}$$

$$(c) \text{Productivity of Land} = \frac{\text{Output}}{\text{Area of land used}}$$

3.3.1 Total Productivity Index

So far we have attempted to measure productivity of individual factors. Productivity can also be measured on aggregate basis as follows :

$$\text{Total Productivity Index} = \frac{\text{Total output}}{\text{Total Inputs}} \text{ or }$$

$$\frac{\text{Total production of goods and services}}{\text{Labour + Materials + Capital + Power}}$$

This index measures the efficiency of the entire organisation in the use of all the resources. It is a strategic yardstick for evaluating the operating efficiency of the entire plant or firm.

3.3.2 Difficulties in Measurement of Productivity

Productivity has been defined as the ratio of output and input. An increase in productivity means an increase in output that is proportionately greater than an increase in inputs. But measurement of outputs and inputs is not a simple matter. When a single product is being manufactured, output can be measured in physical terms, e.g., number of units produced, weight, volume, etc. But in most of the industries more than one product is being manufactured. When an industry produces some by-products, the problem becomes all the more complicated.

Measurement of inputs poses similar problems. Input factors are many and varied. Some of them may not be measurable at all e.g., managerial skill. When it is difficult to compare the output and inputs in physical terms, they have to be converted into money terms for the purpose of comparison. Thus productivity is defined as the ratio of net value of output to the net value of input, all expressed at constant price. But price fluctuations create errors in measurement. Monetary measurements do not measure correctly the changes in quantity. Measurement of productivity is even more difficult in service enterprises.

3.3.3 Importance of Productivity

The resources of a country are generally limited. Therefore, higher productivity is essential for improving living standards and for the prosperity of a nation. Higher productivity requires elimination of waste in all forms. It is necessary to spot and eliminate the wastage of materials, machinery, time, man-power, space and other resources. Several techniques, e.g., work study, value analysis, operations research, SQC, inventory control, ergonomics, etc., are used for this purpose.

Higher productivity leads to economic growth and social progress. It is only by improving productivity that employees can get better wages and working conditions and more employment opportunities. Higher productivity brings lower prices for consumers and higher dividend for shareholders. It improves the exports and foreign exchange reserves of a country. Thus, productivity is the key to prosperity of a nation.

The importance of productivity in India arises because of the following factors :

- (i) **Increase in Production** : A direct consequence of improvement in productivity, in most cases, is an increase in output, be it an organisation or economy as a whole.
- (ii) **Reduction in Costs** : Higher level of productivity means better utilisation of resources which is indicative of reduction in costs—costs of raw materials, labour costs, overheads, marketing costs, administrative costs, etc.
- (iii) **Increase in Profits** : An increase in output accompanied by reduced costs leads to increase in profits of business enterprise.

(iv) **Competitive Advantage** : Higher productivity tends to increase the competitive strength (of the firm as well as that of the economy) through reduction in costs and improvement in quality of output. The country is thus enabled to compete successfully in the international market.

(v) **Better Quality of Life** : Growth in productivity creates the wherewithal to finance social programmes, to improve education, to protect employees, consumers and the environment, and to support leisure-time pursuits. In short, higher productivity is a key to enhance the quality of life of the people.

3.4 FACTORS INFLUENCING PRODUCTIVITY

Productivity is the result of a variety of interrelated and interdependent factors. It is difficult to measure the influence of any one factor separately. The factors that exert profound influence on the level of productivity can be classified into two categories :

- (1) **Internal factors** which could be controlled at the level of the enterprise; and
- (2) **External factors** which are outside the control of the management of the enterprise.

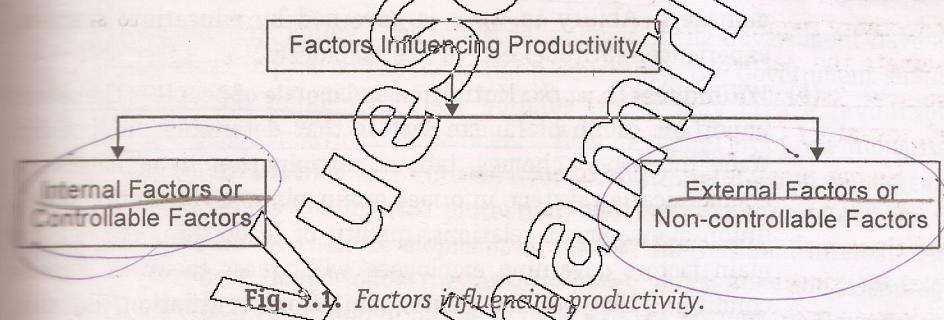


Fig. 3.1. Factors influencing productivity.

Internal Factors :

- (i) **Technological Factors** : Technological factors exercise significant influence on the level of productivity. The main technological factors are as follows :
 - (a) Size and capacity of plant
 - (b) Product design and standardisation
 - (c) Timely supply of materials and fuel
 - (d) Rationalisation and automation measures
 - (e) Repairs and maintenance
 - (f) Production planning and control
 - (g) Plant layout and location

- (h) Materials handling system
- (i) Inspection and quality control
- (j) Machinery and equipment used
- (k) Research and development
- (l) Inventory control
- (m) Reduction and utilisation of waste and scrap, etc.

(ii) Human Factors : Human factors relate to the availability of suitable personnel and their job performance. Personnel (or employees) include men and women working at all levels in the organisation—managers, supervisors, professional staff such as engineers and scientists, other white-collar workers, and blue-collar workers. The existence of adequately skilled personnel is a precondition to an improvement in productivity, be it an economy or an organisation. One reason why the level of productivity is lower in under developed countries is the non-availability of skilled personnel in sufficient number.

While analysing the effect of human factors on productivity, the following two forces among the human resources are worth noting :

(a) **Ability to work :** Productivity of an organisation depends upon the competence and calibre of its people—both workers and managers. Ability to work is governed by education, training, experience, aptitude, etc. of the employees.

(b) **Willingness to work :** Motivation and morale of people is the second important group of human factors that determine productivity. Wage incentive schemes, labour participation in management, communication system, informed group relations, promotion policy, union-management relations, quality of leadership, etc. are the main factors governing employees' willingness to work. Working conditions like working hours, sanitation, ventilation, lighting, temperature, safety measures and welfare amenities like housing, schools, clubs, subsidised canteen, free transport, etc. also influence the motivational level of employees.

(iii) Financial Factors : Capital is the life-blood of business. Unless adequate amount of capital is available to finance such requirements of productive enterprises as modernisation of plant and machinery, mechanisation, rationalisation and research and development, the productivity level will not increase. Research studies have shown that as the capital employed per worker tends to be high, there is an increase in the level of productivity too, and the reverse is true when there is a decline in the amount of capital employed per worker.

(iv) Materials and Energy : Efforts to reduce materials and energy consumption can bring about considerable improvement in productivity.

The factors to be considered are :

- (a) Selection of quality material.
- (b) Control of wastage.
- (c) Effective stock control.
- (d) Development of sources of supply.
- (e) Optimum energy utilisation and energy savings.

External Factors

- (i) **Natural Factors** : Productivity is also affected by physical, geographical and climatic conditions of the place. Thus, people of temperate countries have higher working capacities than those of tropical regions. Further, the abundance of gift of nature in the form of minerals, forests, fertile land, extractive industries, quality raw materials, etc., tend to push up the productivity level.
- (ii) **Sociological Factors** : Social customs, traditions and institutions influence attitudes towards work and job. For instance, bias on the basis of cast, religion, etc., inhibited the growth of modern industry in some countries. The joint family system affected incentive to work hard in India. Close ties with land and native place hampered stability and discipline among the industrial labour.
- (iii) **Government Policy** : The industrial policies of the Government have an important impact on the industrial productivity. The Government should frame and implement such policies which may create favourable conditions for savings, investments, flow of capital from one industrial sector to another and conservation of national resources. Certain industries may be granted protection, and incentives may be given to the others for their development in view of the national interest. The Government should follow the taxation policy which does not discourage the further expansion of business. It is also the duty of the Government to check the growth of monopolistic enterprises so that the interests of the consumers and the workers are not jeopardised.
- (iv) **Managerial Talent** : The significance of managerial talent has increased with the advancement in technology. Professional managers are required to make better use of the new technological developments. Since the modern enterprises are run on large scale, the managers must possess imagination, judgement and willingness to take initiative. The managers should be devoted towards the owners of the business, workers, customers, suppliers, Government and the society. This is essential if the managers want to manage their organisations effectively. The managers should have conceptual, human relations and technical skills in order to increase the productivity of the enterprise.

BOX 1

CAUSES OF POOR PRODUCTIVITY

- (i) Improper design of product.
- (ii) Incorrect quality standards.
- (iii) Improper technology.
- (iv) Improper process control leading to wastage and reprocessing.
- (v) Improper layout.
- (vi) Lack of right types of workers.
- (vii) Poor working conditions.
- (viii) Poor quality of materials.
- (ix) Breakdowns and accidents.

3.5 INCREASING INDUSTRIAL PRODUCTIVITY

The following steps have been found to be useful in enhancing productivity of resources :

- (i) **Improved Raw Materials** : Raw materials of right quality should be procured and used by every industrial unit. This will reduce wastage and increase the productivity of workers and machines.
- (ii) **Better Technology** : Latest machines and equipment should be procured by the industrial units as they are more efficient and economical. The industrial units using old machines have low productivity and so can't compete with those units using new technology.
- (iii) **Scientific Selection and Training of Workers** : In order to handle various positions in the organisation, right type of employees should be appointed. They should also be provided adequate training in the use of raw materials, machines, etc.
- (iv) **Work Study** : Scientific analysis and improvement of work in all its aspects is a very useful technique of increasing productivity. Work study results in improvements in plant layout, material handling system, process design and standardisation, working conditions etc. These in turn help to minimise defective work and waste.
- (v) **Research and Development** : Continuing research and development (R & D) leads to the discovery of better techniques of production and improvements in existing machinery, equipment etc. The rate of technological progress is a direct determinant of productivity. That is why, companies and countries spend huge sum of money on research and development activities.

- (vi) **Good Working Conditions :** There should be proper arrangements of lighting, ventilation, cleanliness, cooling and heating of work-place. If these arrangements are not proper, productivity is likely to be low.
- (vii) **Provision of Incentives :** Workers should be offered incentives to increase their productivity. Workers with good record of productivity should be recognised and suitably rewarded. Productivity linked bonus plan may be introduced to get good response from the workers.
- (viii) **Harmonious Relations :** There should be industrial peace in the organisation. Cordial relations between the workers and the management are key to higher productivity. Higher production targets can be achieved if there are minimum possible conflicts between the workers and the management.
- (ix) **Quality and Cost Consciousness :** Both the workers and the management should be conscious about cost and quality. This will reduce unnecessary wastages in the production process.
- (x) **Workers' Participation in Management :** Labour participation in management is considered an effective tool for improving productivity. It helps in developing mutual understanding and cooperation between management and labour. Joint consultation, suggestion schemes, two-way communication, grievance procedure are the main forms of workers' participation in management.
- (xi) **Quality Circles (QC) :** A quality circle is a small group of workers which regularly meets to discuss problems, investigate causes, recommend solutions and if authorised, to take corrective action. It usually consists of five to ten members who collectively identify, analyse and resolve work-related problems and may even implement solutions. The purpose of a quality circle programme is to improve motivation, productivity and product quality. It is designed to optimise the manpower by capturing the creative and innovative power of the workforce. It provides workers an opportunity to participate in decisions about their work. As a result, they take greater interest in their jobs. It develops a sense of participation among the workers.

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Law of Variable Proportion / Law of Single Variable Proportion / Law of Diminishing Return / Law of Diminishing Marginal Return

Law of Variable Proportions

- The Law of Variable Proportions examines the production function i.e. the input-output relation in short run where one factor is variable and other factors of production are fixed.
- In other words, it examines production function when the output is increased by varying the quantity of one input.
- Thus, the law examines the effect of change in the proportions between fixed and variable factor inputs on output in three stages viz. Increasing returns, diminishing returns and negative returns.

Statement of the Law :-

“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”. (F. Benhan)

The law operates under some assumptions which are as follows:-

1. There is only one factor which is variable. All other factors remain constant.
2. All units of variable factor are homogeneous
3. It is possible to change the proportions in which the various factors are combined.
4. The state of technology is given and is constant.

The three stages of the law can be explained with the help of the following schedule and diagram.

Table : Law of variable proportions

Units of Fixed Factor CAPITAL	Units of Variable factor LABOUR	Ratio of Factors	Total Product	Average Product	Marginal Product	Stages of the Law
10	1	10:1	10	10	10	Stage I Increasing Returns to Factor
10	2	10:2	30	15	20	
10	3	10:3	60	20	30	
10	4	10:4	80	20	20	Stage II Diminishing Returns to Factor
10	5	10:5	90	18	10	
10	6	10:6	90	15	0	
10	7	10:7	85	12.1	-5	Stage III Negative Returns to Factor

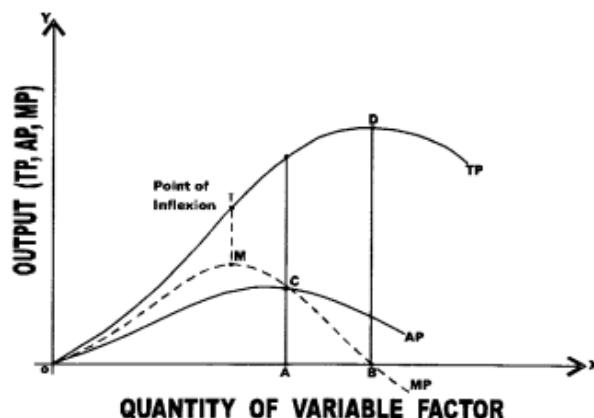


Figure : Law of variable proportions

Stage I: The Law of Increasing Returns to Factor –

- During this stage, total product (TP) increases at an increasing rate upto the point of inflexion 'I' and thereafter it increases at diminishing rate.
- This is because marginal product (MP) of the variable factor increases upto point 'M' on MP curve and then start falling.
- Rising MP also pulls up average product (AP), which goes on rising, in the first stage.
- Rising AP indicates increase in the efficiency of variable factor i.e. labour.
- Stage I ends where AP is maximum and is equal to MP as shown by point 'C' in the diagram.

The law of increasing returns operates because of the following two reasons:

1. Indivisibility of fixed factors

- Due to indivisibility, the quantity of fixed factors is more than the quantity of variable factors.

- So when the quantity of variable factors is increased to work with fixed factors, output increases speedily due to full and effective utilisation of fixed factors.
- In other words, efficiency of fixed factors increases.

2. Efficiency of Variable Factor Increases

Due to increase in the quantity of variable factor, it becomes possible to introduce DIVISION OF LABOUR leading to SPECIALISATION. This results in more output per worker.

Stage II: The Law of Diminishing Returns to Factor –

- In second stage, TP continues to increase at diminishing rate. It reaches the maximum at point 'D' in the diagram, where the second stage ends.
- In this stage, both AP and MP of variable factor are falling- though remains positive. That is why this stage is called as the stage of diminishing returns.
- At the end of this stage MP becomes, zero as shown by point 'B' in the diagram and corresponding to highest point 'D' on TP curve.

The law of diminishing returns operate due to the following two reasons:

1. Indivisibility of fixed factors

- Once the optimum proportion between indivisible fixed factors and variable factors is reached (as in Stage I) with any further increase in the quantity of Variable factor, the fixed factors become inadequate and are overutilised.
- The fine balance between fixed and variable factor gets disturbed. This causes AP and MP to diminish.

2. Imperfect Substitutability of factors

- Variable factors are not perfect substitute of fixed factors.
- The elasticity of substitution between factors is not infinite.

Stage III: The Law of Negative Returns to Factor –

- In third stage, TP falls and so, TP curve slopes downward. MP becomes negative and the MP curve goes below the X-axis. AP continues to fall.
- As the MP of variable factor becomes negative, this stage is called the stage of negative returns.
- In this stage the efficiency of fixed and variable factors fall and factor ratio becomes highly sub-optimal.

The law of negative returns operate due to the following reasons:

1. The quantity of the variable factor becomes too excessive compared to fixed factors. They get in each other's way and so TP falls and MP becomes negative.

2. Too large number of variable factors also reduce the efficiency of fixed factors.

Conclusion -Where to operate?

1. A rational firm will not produce either in Stage I or in Stage III.
2. In stage I, the marginal product of fixed factor is negative as its quantity is more than variable factor.
3. In stage III, the marginal product of variable factor is negative as its quantity is too large than fixed factor.
4. Therefore, firm would seek to produce in Stage II where both AP and MP of Variable factor are falling.
5. At which point to produce in this stage will depend on the prices of factor inputs.

Returns to Scale

- Returns to Scale is applied in production in long run.
- In long run all factors of production are variable.
- Returns to scale are of three types
 - I) constant return to scale
 - II) increasing return to scale
 - III) decreasing return to scale

I) constant return to scale

For constant returns to scale to occur, the relative change in production should be equal to the proportionate change in the factors.

For example, if all the factors are proportionately doubled, then constant returns would imply that the production output would also double. Interestingly, the production function of an economy as a whole exhibits close characteristics of constant returns to scale.

Also, studies suggest that an individual firm passes through a long phase of constant return to scale in its lifetime. Lastly, it is also known as the linear homogeneous production function.

II) increasing return to scale

Here, the proportionate increase in production is greater than the increase in inputs. Note that upon expansion, a firm experiences increasing returns to scale. The indivisibility of factors is another reason for this.

Some factors are available in large units, such that they are completely suitable for large-scale production. Evidently, if all the factors are perfectly divisible then there might be no increasing returns. Further, specialization of land and machinery can be another reason.

III) decreasing return to scale

An incidence of decreasing returns to scale would mean that the increase in output is less than the proportionate increase in the input. Generally, this happens when a firm expands all its inputs, especially a large firm.

When the firm expands to a very large size, it becomes difficult to manage it with the same efficiency as before. Hence, the increasing complexity in management, coordination, and control eventually leads to decreasing returns.

Cobb Douglas Production Function

$$Y = A * L^\beta * K^\alpha$$

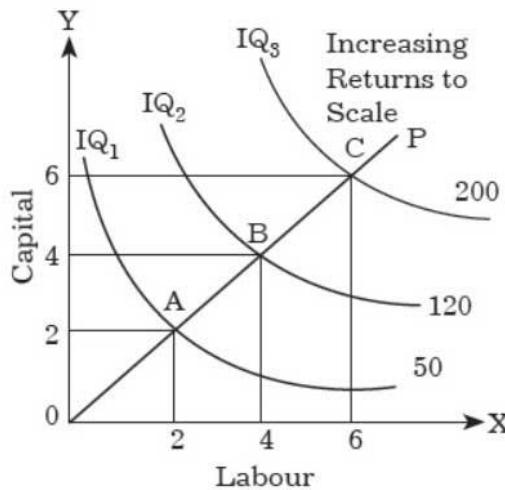
Y = output / production

A= constant

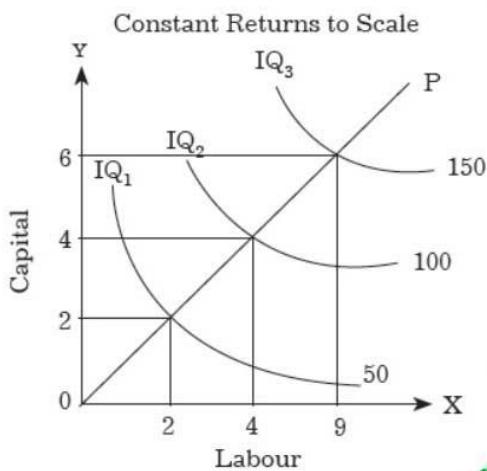
L= labour

K= capital

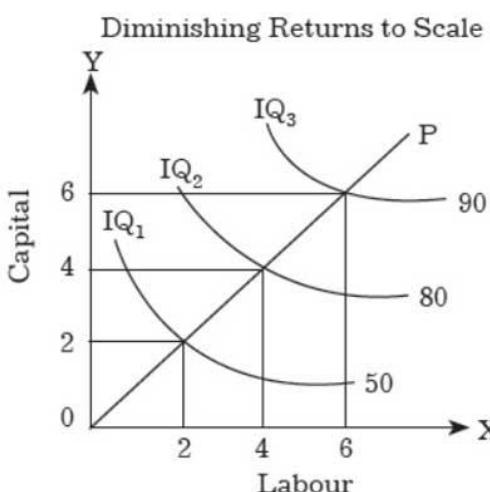
- If $\alpha + \beta > 1$, there are increasing returns to scale.
- For $\alpha + \beta = 1$, we get constant returns to scale.
- If $\alpha + \beta < 1$, we get decreasing returns to scale.



INCREASING RETURNS TO SCALE



CONSTANT RETURNS TO SCALE



DIMINISHING RETURNS TO SCALE



Isoquant Curve: Definition, Properties, Types, Assumptions

- Isoquant—iso means same or equal & quant means quantity
- In isoquant analysis output remains constant. It does not change.
- Production or output depends upon two factors. If one factor increases then other factor decreases so that output remains constant.
- Isoquant curves are also called as equal product curves or production indifference curves.

Isoquant curve definition :- 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.

Assumptions of Isoquant Curve

The assumptions of an isoquant curve are as follows:

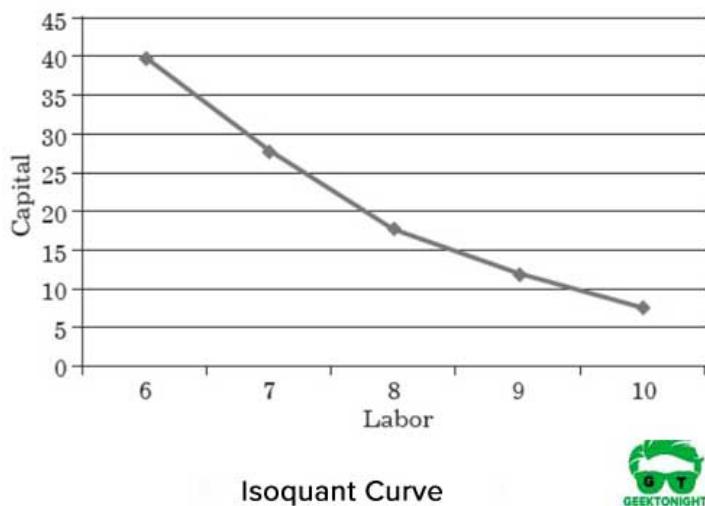
- There are only two factor inputs, labour and capital, to produce a particular product.
- Capital, labour and goods are divisible in nature.
- Capital and labour are able to substitute each other up to a certain limit.
- Technology of production is given over a period of time.
- Factors of production are used with full efficiency.

Let us learn isoquant with the help of the following table.

Table 1 shows the different combinations of two factor inputs, namely, labour and capital for producing 150 tonnes of output:

LABOUR	CAPITAL
6	40
7	28
8	18
9	12
10	8

Figure 1 shows the isoquant curve of different labour capital combinations that help in producing 150 tonnes of output:



Properties of Isoquant Curve

Some of the properties of isoquant curve are as follows:

1. Isoquant curves slope downwards
2. Isoquant curves are convex to origin
3. Isoquant curves cannot intersect each other
4. Higher the isoquant the higher the output

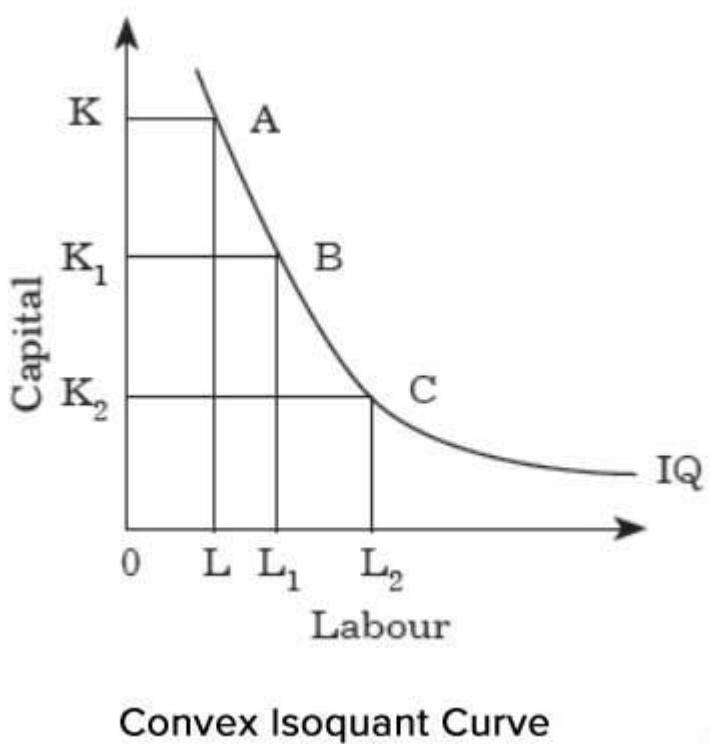
Isoquant curves slope downwards

It implies that the slope of the isoquant curve is negative. This is because when capital (K) is increased, the quantity of labour (L) is reduced or vice versa, to keep the same level of output.

Isoquant curves are convex to origin

It implies that factor inputs are not perfect substitutes. This property shows the substitution of inputs and diminishing marginal rate of technical substitution of isoquant. The marginal significance of one input (capital) in terms of another input (labour) diminishes along with the isoquant curve.

Figure 2 shows the convex isoquant curve:



Isoquant curves cannot intersect each other

An isoquant implies the different levels of combination producing different levels of inputs. If the isoquants intersect each other, it would imply that a single input combination can produce two levels of output, which is not possible. The law of production would fail to be applicable.

Higher the isoquant the higher the output

It implies that the higher isoquant represents higher output. The upper curve of the isoquant produces more output than the curve beneath.

This is because the larger combination of input results in a larger output as compared to the curve that is beneath it.

Marginal Rate of Technical Substitution

The slope of the isoquant curve is the rate of substitution that shows how one input can be substituted for another while holding the output constant. This is called marginal rate of technical substitution (MRTS).

According to Lipsey, “the marginal rate of technical substitution may be defined as the rate at which one factor is substituted for another with output held constant.”

The formula for calculating MRTS is as follows:

$$\text{MRTS} = -\Delta K / \Delta L$$

where, ΔK = Change in capital

ΔL = Change in labour

The formula shows that at a given level of output, MRTS of capital for labour would imply the amount of labour that the firm would be willing to give up for an additional unit of capital. Similarly, MRTS of labour for capital would imply the amount of capital that the firm would be willing to give up for an additional unit of labour.

The MRTS is calculated as shown in Table 2

LABOUR	CAPITAL	MRTS
6	40	
7	28	12:1
8	18	10:1
9	12	6:1
10	8	4:1

- **Isoquant map :-** when different isoquant curves are shown in the same diagram it is called isoquant map.

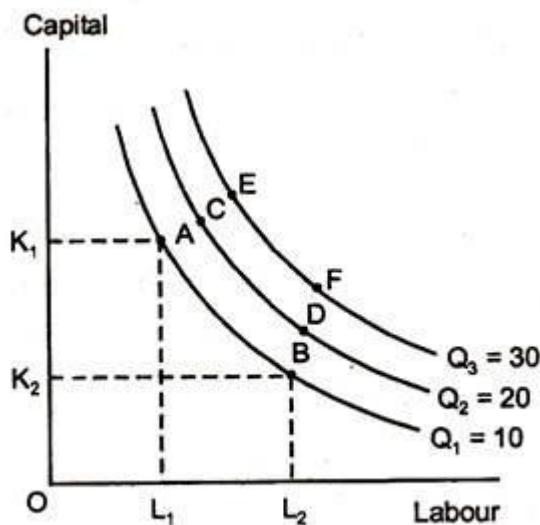


Fig. 6.3 : Isoquant Curve/Isoquant Map

Economies of Scale

What Are Economies of Scale?

Economies of scale are cost advantages reaped by companies when production becomes efficient. Companies can achieve economies of scale by increasing production and lowering costs. This happens because costs are spread over a larger number of goods. Costs can be both fixed and variable.

Economies of scale can be both internal and external. Internal economies are caused by factors within a single company while external factors affect the entire industry.

Internal vs. External Economies of Scale

As mentioned above, there are two different types of economies of scale. Internal economies are borne from within the company. External ones are based on external factors.

Internal economies of scale happen when a company cuts costs internally, so they're unique to that particular firm. This may be the result of the sheer size of a company or because of decisions from the firm's management. Larger companies may be able to achieve internal economies of scale—lowering their costs and raising their production levels—because they can buy resources in

bulk, have a patent or special technology, or because they can access more capital.

External economies of scale, on the other hand, are achieved because of external factors, or factors that affect an entire industry. That means no one company controls costs on its own. These occur when there is a highly-skilled labor pool, subsidies and/or tax reductions, and partnerships and joint ventures—anything that can cut down on costs to many companies in a specific industry.

SAC &LAC (short run average cost curve and long run average cost curve and its relation)

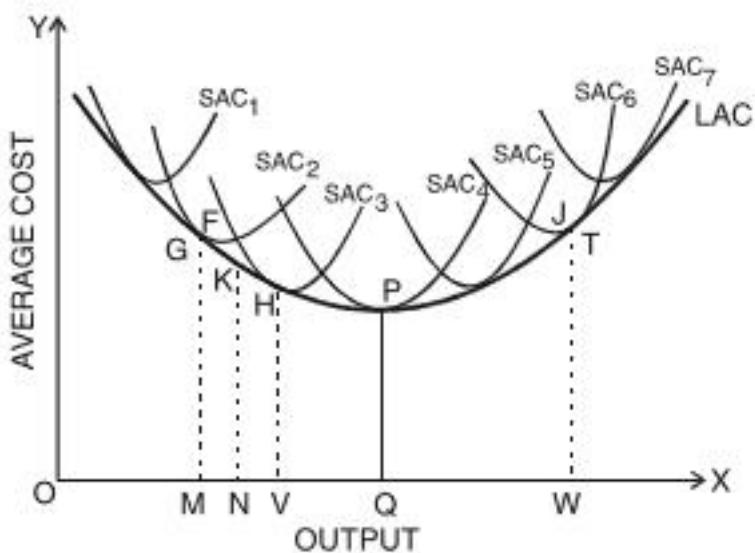


Fig.2 : Long run Average Cost Curves

- Short run means 3 months, 6 months, up to 1 year
- Some factors of production remains constant in short run (ex. Plant, land , technology etc.)
- Long run means 5 years or 10 years or 15 years etc.
- All factors are variable in long run. No factor remains constant.

- Average cost curve in short run is called short run average cost curve SAC
- Average cost curve in long run is called long run average cost curve LAC
- LAC curves include different SAC curves.
- Different points of LAC curve lie on some SAC curve.
- Average cost first decreases then becomes minimum and then again increases.

|

THEORY OF COST

MEANING OF COST- Cost may be defined as the monetary value of all sacrifices made to achieve an objective i.e. to produce goods and services. Cost are very important in business decision making. Cost of production provides the floor to pricing. It helps manager to take correct decision, such as what price to quote, whether to place particular order for inputs or not whether to abandon or add a product to the existing product line and so on.

Ordinarily, cost refer to the money expenses incurred by a firm in the production process. Cost also included imputed value of the entrepreneur's own resources and services, as well as salary of the owner-manager.

DETERMINANTS OF COST-

Factors determining the cost are:

- (a) Size of plant: There is an inverse relationship between size of plant and cost. As size of plant increases, cost falls and vice versa.

(b) Level of Output: There is a direct relationship between output level and cost. More the level of output, more is the cost (i. e., total cost) and vice Versa.

(c) Price of Inputs: There is a direct relationship between price of inputs and cost. As the price of inputs rises, cost rises and vice versa.

(d) State of technology: More modern and upgraded the technology implies lesser cost and vice versa.

(e) Management and administrative efficiency: Efficiency and cost are inversely related. More the efficiency in management and administration better will be the product and less will be the cost. Cost will increase in case of inefficiencies in management and administration.

COST CONCEPT-

The concept of cost is central to business decision making. To make effective business decisions, the business manager needs to be aware of a number of cost concepts and their respective uses.

Actual cost- Actual cost means the actual expenditure incurred on producing goods and services. Value of raw material, wages, rent, salaries paid and interest of borrowed capital etc. are some of the example of actual cost. Actual cost is also known as absolute cost or out lay cost or money cost.

Opportunity Cost- The opportunity cost is measured in terms of the forgone benefits from the next best alternative use of a given resource. For example the inputs which are used to manufacture a car may also be used in the productions of military equipment. Main points of opportunity cost are:

1. The opportunity cost of any commodity is only the next best alternative forgone.
2. The next best alternative commodity that could be produced with the same value of the factors, which are more or less the same.

3. It helps in determining relative prices of factor inputs at different places.
4. It helps in determining the remuneration to services.
5. It helps the manager to decide what he should produce in the factory.

Explicit cost- An explicit cost is a cost that is directly incurred by the firm, company or organization during the production. The explicit cost is kept on record by the accountant of the firm. Salaries, wages, rent, raw material are few example of the explicit cost. The explicit cost is also known as out-pocket cost. This cost is handy in calculating both accounting and economic profit.

Implicit cost- The implicit cost is directly opposite to it, as it is the cost that is not directly incurred by the firm or company. In implicit cost outflow of cash doesn't take place. It is not in the record and is hard to be traced back. The interest on owner's capital or the salary of the owner are the prominent example of the implicit cost. The implicit cost is also known as imputed cost. Through implicit cost , only the economic profit is calculated.

Incremental cost- Incremental costs are the added costs of a change in the level of production or the nature of activity. It may be adding a new product or changing distribution channel, or adding new machinery, etc. It appears to be similar to marginal cost, but it is not managerial cost. Marginal cost refers to the cost on added unit of output.

Sunk Cost- Sunk costs are costs which cannot be altered in any way. Sunk costs are costs which have already been incurred. For example, cost incurred in constructing a factory. When the factory building is constructed cost have already been incurred. The building has to be used for which originally envisaged. It can not be altered when operation are increased or decreased . Investment of machinery is an example of sunk cost.

Shutdown cost- Shutdown cost are those cost which would be incurred in the event of suspension of plant operations and which could be saved if operation

were continued. For example cost of sheltering the plant equipment and construction of sheds for protecting the exposed property, or fixed cost and maintenance cost etc.

Abandonment cost- Abandonment cost are those cost which are incurred for the complete removal of the fixed asset from use. These may occur due to obsolesce or due to improvisation of the firm. Abandonment costs thus involve problem of disposal of the asset.

Book cost – Book cost are those business cost which don't involve any cash payment is made but a provision is made in the books of accounts in order to include them in the profit and loss account and take tax advantages.

Out of pocket cost- Out of pocket cost are those costs or expenses which are current payments to the outsiders of the firm. All the explicit costs fall into the category of out of pocket costs.

Past cost- Past costs are actual costs incurred in the past. These costs are mentioned in the financial accounts. , since the past costs have already been incurred, and there is no scope for managerial decision. If the management finds out that the past costs are excessive, it cannot do anything to rectify it now.

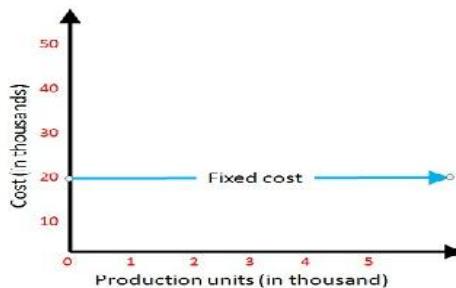
Future cost- Future costs are those costs which are to be incurred in the near future. This is only a forecast. Future costs matter for managerial decisions because, the management can evaluate the desirability of that expenditure. In the case of future costs, if the management considers them very high , it can either reduce them or postpone the use of them.

Direct cost-Direct costs are related to a specific process or product. They are also called traceable costs as we can directly trace them to a particular activity, product or process. They can vary with changes in the activity or product. Examples of direct costs include manufacturing costs relating to production, customer acquisition costs pertaining to sales, etc.

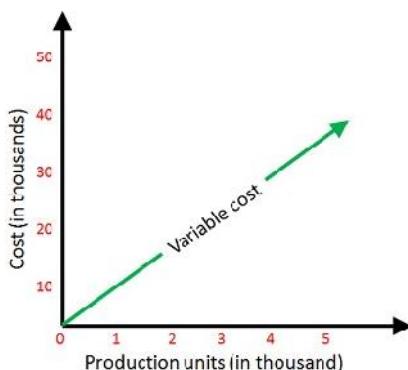
Indirect costs- Indirect costs, or untraceable costs, are those which do not directly relate to a specific activity or component of the business. For example, an

increase in charges of electricity or taxes payable on income. Although we cannot trace indirect costs, they are important because they affect overall profitability.

Fixed Cost- Fixed cost are the amount spent by the firm on fixed inputs in the short run. Fixed cost are thus, those costs which remain constant, irrespective of the level of output. These costs remain unchanged even if the output of the firm is nil. Fixed costs therefore, are known as Supplementary costs or Overhead costs.



Variable Costs- Variable costs are those cost that change directly as the volume of output changes. As the production increases variable cost also increases, and as the product decreases variable costs also decreases, and when the production stops variable cost is zero.



Semi Variable Cost- This type of cost lies in between fixed and variable cost. It is neither perfectly variable nor perfectly fixed in relation to changes in output. This type of costs include a portion of fixed cost and a portion of variable cost, this is known as semi variable cost. For example- electricity bill generally include both a fixed charge (meter rent) and a variable charge(charge based on units consumed) and the total payment made is semi variable cost.

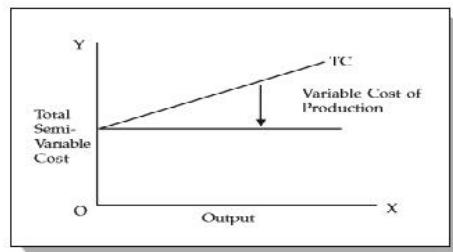
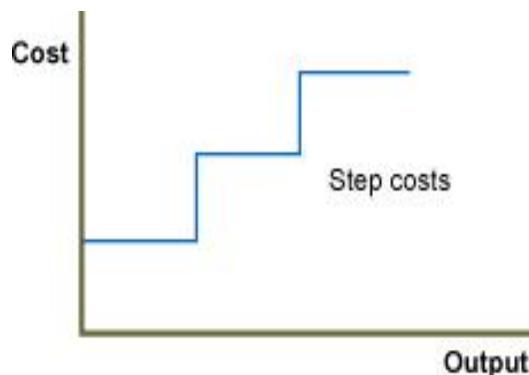


Fig. 3 : Semi Variable Cost

Stair Step Cost- Certain expenses increase in a stair step manner, i.e. remaining constant over a range of output but rising suddenly to a new higher level as output passes beyond. The given level. For example- up to a point the attendants salary may remain fixed as output increases but beyond that point further increase in output may require an additional attendant leading to a sudden jump in supervision expenses.



Total cost- Total cost is the total expenditure incurred in the production of goods and services.

$$TC = TFC + TVC$$

Average cost- Average cost is not actual cost, It is obtained by dividing the total cost by the total output.

$$AC = \text{Total Cost}/\text{Units Produced}$$

Marginal cost- The cost incurred on producing one additional unit of commodity is known as marginal cost. Thus it shows a change in total cost when one more or less unit is produced.

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

Cost function-

The cost output relationship plays an important role in determining the optimum level of production.

$$TC = F(Q)$$

Where,

TC= Total cost

Q= Quantity produced

F= Function

The cost function can be classified as:

Short run cost- Short run is a period where the time is too short to expand the size of industry and the increased demand has to be met within the existing size of industry because there are certain factors which cannot be changed in short run. So short run costs are those which vary with output when fixed plant a capital equipments remain unchanged.

Long run costs- In the long run the size of an industry can be expanded to meet the increased demand for products such as in long run all the factors of production can be increased according to need. Hence long run costs are those which vary with output when all input factors including plants equipment vary.

Cost output relationship in short run-

In the short-run a change in output is possible only by making changes in the variable inputs like raw materials, labour etc. Inputs like land and buildings, plant and machinery etc. are fixed in the short-run. It means that short-run is a period not sufficient enough to expand the quantity of fixed inputs. Thus Total Cost (TC) in the short-run is composed of two elements – Total Fixed Cost (TFC) and Total Variable Cost (TVC).

TFC remains the same throughout the period and is not influenced by the level of activity. The firm will continue to incur these costs even if the firm is temporarily shut down. Even though TFC remains the same fixed cost per unit varies with changes in the level of output.

On the other hand TVC increases with increase in the level of activity, and decreases with decrease in the level of activity. If the firm is shut down, there are no variable costs. Even though TVC is variable, variable cost per unit is constant.

So in the short-run an increase in TC implies an increase in TVC only. Thus:

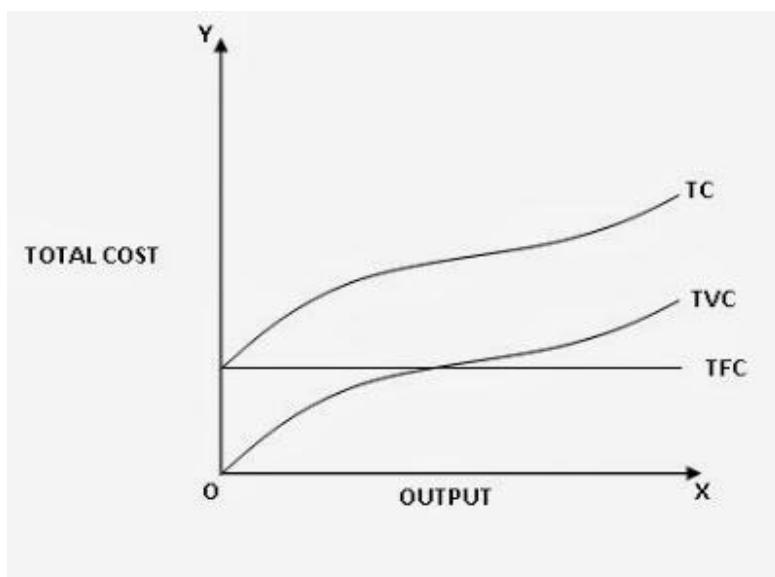
$$TC = TFC + TVC$$

$$TFC = TC - TVC$$

$$TVC = TC - TFC$$

TC = TFC when the output is zero.

The graph below shows Short-run cost output relationship.



In the graph X-axis measures output and Y-axis measures cost. TFC is a straight line parallel to X-axis, because TFC does not change with increase in output.

TVC curve is upward rising from the origin because TVC is zero when there is no production and increases as production increases. The shape of TVC curve depends upon the productivity of

the variable factors. The TVC curve above assumes the Law of Variable Proportions, which operates in the short-run.

TC curve is also upward rising not from the origin but from the TFC line. This is because even if there is no production the TC is equal to TFC.

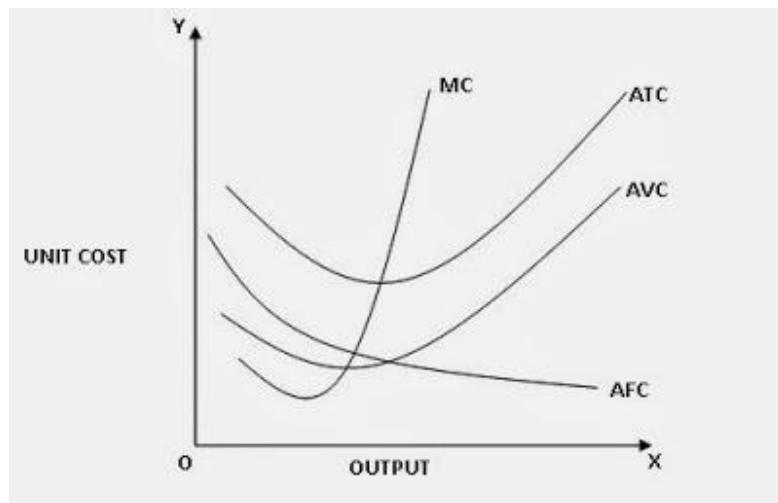
It should be noted that the vertical distance between the TVC curve and TC curve is constant throughout because the distance represents the amount of fixed cost which remains constant. Hence TC curve has the same pattern of behavior as TVC curve.

Short-run Average Cost and Marginal Cost

The concept of cost becomes more meaningful when they are expressed in terms of per unit cost. Cost per unit can be computed with reference to fixed cost, variable cost, total cost and marginal cost.

The following Table and diagram illustrates cost output relationship in the short-run, with reference to different concepts of cost.

Output	Total Fixed Cost (TFC)	Total Variable Cost (TVC)	Total Cost (TC)	Average Fixed Cost (AFC)	Average Variable Cost (AVC)	Average Total Cost (ATC)	Marginal Cost (MC)
1	2	3	$4 = 2 + 3$	$5 = 2 / 1$	$6 = 3 / 1$	$7 = 4 / 1$	8
0	240	0	240	—	—	—	—
1	240	120	360	240	120	360	120
2	240	200	440	120	100	220	80
3	240	270	510	80	90	170	70
4	240	320	560	60	80	140	50
5	240	420	660	48	84	132	100
6	240	552	792	40	92	132	132
7	240	720	960	34	103	137	168



Average Fixed Cost (AFC): Average fixed cost is obtained by dividing the TFC by the number of units produced. Thus:

$$AFC = TFC/Q \quad \text{where, 'Q' refers to quantity of production.}$$

Since TFC is constant for any level of activity, fixed cost per unit goes on diminishing as output goes on increasing. The AFC curve is downward sloping towards the right throughout its length, with a steep fall at the beginning.

Average Variable Cost (AVC): Average Variable Cost is obtained by dividing the TVC by the number of units produced. Therefore:

$$AVC = TVC / Q$$

Due to the operation of the Law of Variable Proportions AVC curve slopes downwards till it reaches a certain level of output and then begins to rise upwards.

Average Total Cost (ATC): Average Total Cost or simply Average Cost is obtained by dividing the TC by the number of units produced. Thus:

$$ATC = TC / Q$$

The ATC curve is very much influenced by the AFC and AVC curves. In the beginning both AFC curve and AVC curve decline and therefore ATC curve also declines. The AFC curve continues the trend throughout, though at a diminishing rate. AVC curve continues the trend till it reaches a certain level and thereafter it starts rising slowly. Since this rise initially is at a rate lower than the rate of decline in the AFC curve, the ATC curve continues to decline for some more time and reaches the lowest point, which obviously is further than the lowest point of the AVC curve. Thereafter the ATC curve starts rising because the rate of rise in the AVC curve is greater than the rate of decline in the AFC curve.

Marginal Cost (MC): Marginal Cost is the increase in TC as a result of an increase in output by one unit. In other words it is the cost of producing an additional unit of output.

$$MC = \Delta TC / \Delta Q \quad \text{Where, } \Delta TC = \text{Change in Total cost}$$

$$\Delta Q = \text{Change in quantity}$$

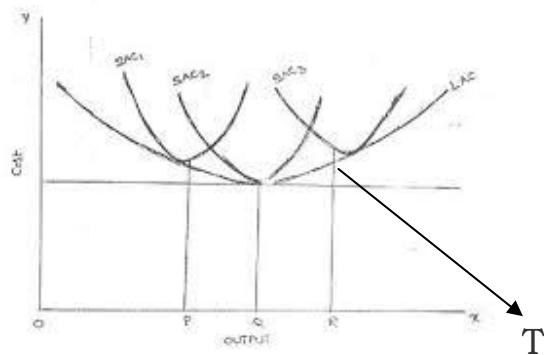
MC is based on the Law of Variable Proportions. A downward trend in MC curve shows decreasing marginal cost (i.e. increasing marginal productivity) of the variable input. Similarly an upward trend in MC curve shows increasing marginal cost (i.e. decreasing marginal productivity). MC curve intersects both AVC and ATC curves at their lowest points.

The relationship between AVC, AFC, ATC and MC can be summed up as follows.

1. If both AFC and AVC fall ATC will also fall because $ATC = AFC + AVC$
2. When AFC falls and AVC rises (a) ATC will fall where the drop in AFC is more than the rise in AVC (b) ATC remains constant if the drop in AFC = the rise in AVC, and (c) ATC will rise where the drop in AFC is less than the rise in AVC.
3. ATC will fall when MC is less than ATC and ATC will rise when MC is more than ATC. The lowest ATC is equal to MC.

Cost output relationship in the long run-

In order to study the cost output relationship in the long run it is necessary to know the meaning of long run. As known in the long run the size of an industry can be expanded to meet the increased demand for products as such in the long run all the factors of production can be varied according to the need. Hence long run costs are those which vary with output when all the input factors including plant and equipment vary.



As per the above figure suppose that at a given time the firms operate under plant SAC_2 and produces output OQ . If the firm decides to produce output OR and continues with the current plant SAC_2 its average cost will be uR . But if the firm decides to increase the size of the plant to plant SAC_3 its average cost of producing OR output would then be TR . Since cost TR is less than the cost on old plant uR , therefore new plant SAC_3 is preferable and should be adopted. Thus the long run cost of producing OR output will be TR which can be obtained by increasing the plant size.

Features of LAC curve

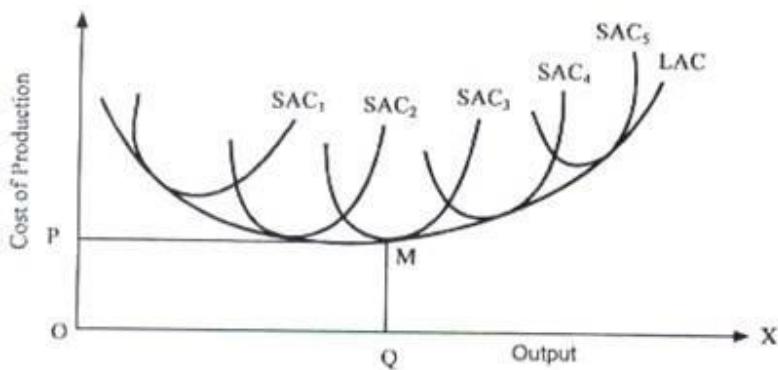


Fig 11.12: Derivation of LAC Curve from SAC Curves

To draw long run average cost curve(LAC) we start with a number of short run average cost(SAC) curves, each such curve representing a particular size of plant including the optimum plant. One can now draw a LAC curve which is tangential to all SAC curves. In this connection following features are highlighted:

- 1- The LAC curve envelopes the SAC curves and is therefore called as envelope curve.
- 2- Each point of the LAC is a point of tangency with the corresponding SAC curve.
- 3- The points of tangency on the falling part of SAC curve for points lying to the left of minimum point of LAC.
- 4- The points of tangency occur on the rising part of the SAC curves for the points lying to the right of minimum point of LAC.
- 5- The optimum scale of plant is a term applied to the most efficient of all scales of plants available. This scale of plant is the one whose SAC curve forms the minimum point of LAC curve. It is SAC₃ in our case which is tangent to LAC curve at its minimum point at R.
- 6- Both LAC ad SAC curves are U shaped but the difference between the two U shapes is that the U shape of the LAC curve is flatter or lesser pronounced from bottom. The main reason for this is that in the long run such economies are possible which cannot be had in the short run, likewise some of the diseconomies which are faced in short run may not be faced in the long run.