Unit III

Production implies the conversion of inputs into goods and services.
Production is the transformation of resources into commodities over a time and space.
Production is the act of converting inputs into outputs.

Production Function: According to Stigler, "The production function is referred as the relationship between a rate of inputs of productive services and the rate of output of product.

The **factors of production** such as land, labour, capital and entrepreneur/organization are the traditional factors, while the factors like technology and knowledge have also been regarded as the important factors of production. "The technical relationship between the units of factors of production and the unit of production of commodity (services) is called as 'production function.'
In mathematical terms the production function is stated as,

P=f (L1, L2, C, T, E or O)

P= Production/Output;
F= Function;
L1= Land;
L2= Labour;
C= Capital;
T= Technology;
E= Entrepreneur;
O= Organisation;

Concepts of Production:

1. **Total Production (TP):** Total production means the total number of units of output produced per unit of time by all factor inputs. In the short sun the total output obviously increases due to the change in variable factor inputs mathematically, it is shown as. TP = f (QVF)
   TP = Total Product
   f = Functional Relationship
   QVF = The Quantity of variable factor.

2. **Average Production (AP):** The average production means total production per unit of given variable factor. In short, by dividing the total product by the quantity of variable factors, we get average product,

Mathematically, AP = TP/ QVF;
TP = Total Product
QVF = the quantity of variable factors

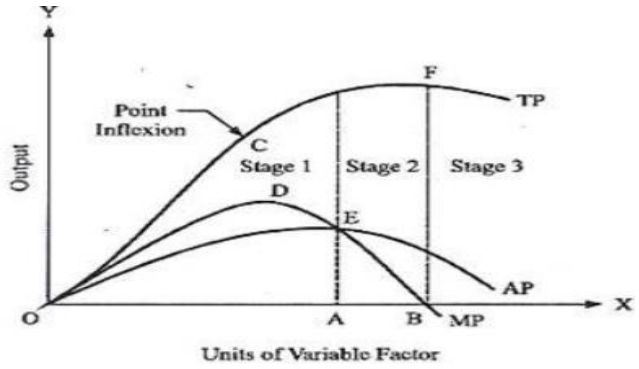
Suppose the total product of commodity is 500 units per day with 25 workers employed, then AP = 500/ 25=20units per workers. This is called as average Production (AP).

3. **Marginal Production (MP):** The additional unit produced by the last variable factor is called as marginal production. In other words if total production change owing to the addition of a variable factor, all other factors being constant, the addition realized in the total product is technically regarded as marginal product (M.P.).

Production function with one variable input or Law of Variable Proportion

The production function with two variable inputs examines the relationship between changes in the quantities of two inputs and their impact on the level of output. While other inputs are assumed to remain constant, the two variable inputs can be adjusted to observe their combined effect on production.

Fixed factor	Variable Factor	TP (Units)	AP(Units)	MP(Units)	Phases
1	1	10	10	10	Increasing
1	2	30	15	20	
1	3	45	15	15	Decreasing
1	4	52	13	7	
1	5	52	10.4	0	Zero
1	6	48	8	-4	Negative



Stage I: The total production increased at an increasing rate. We refer to this as increasing stage where the total product, marginal product and average production are increasing. This stage continues up to the point where the MP is equal to AP.

Stage II: The total production continues to increase but at a diminishing rate until it reaches the next stage. Marginal product, average product are declining but are positive. The total production is at the maximum level at the end of the second stage with a zero marginal product.

Stage III: In this third stage total production declines and marginal product becomes negative. And the average production also started decline. This implies that the change in input factors there is a decline in the overall production along with the average and marginal.

Production Function with Two variables inputs

Iso Quants: Iso means equal, quant means Quantity. It means that the quantities throughout a given isoquants are equal also called as **Iso-product curves**. Every combination is a good combination for the manufacturer. Since he prefer all these combinations equally, so is also called **"Product indifference Curve**" ISO-product curve is a curve which represents all the possible combinations of two factors of production which produce equal amounts of production. A given output can be achieved by employing different combinations of factors of production.

Table 17.1

Factor Combinations to Produce a Given or Level of Output

Factor Combinations	*Labour*	*Capital*
A	1	12
B	2	8
C	3	5
D	4	3
E	5	2

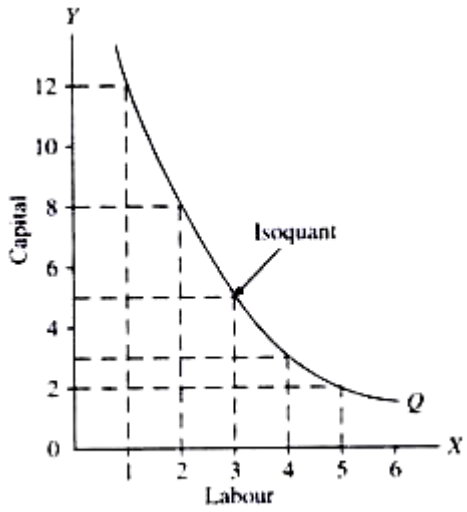


Fig. 17.1. *Isoquant*

The concept of isoquant can be easily understood from Table 17.1. It is presumed that two factors labour and capital are being employed to produce a product. Each of the factor combinations A. B, C, D and E produces the same level of output, say 100 units. To start with, factor combination A consisting of 1 unit of labour and 12 units of capital produces the given 100 units of output.

Similarly, combination B consisting of 2 units of labour and 8 units of capital, combination C consisting of 3 units of labour and 5 units of capital, combination D consisting of 4 units of labour and 3 units of capital, combination E consisting of 5 units of labour and 2 units of capital are capable of producing the same amount of output, i.e., 100 units. In Fig. 17.1 we have plotted all these combinations and by joining them we obtain an isoquant showing that every combination represented on it can produce 100 units of output.

Features of Iso-Product/ Isoquant Curve:

1. **ISO-Product Curves Slope Downwards to the Right**: It implies that a decrease in the quantity of one factor of production must be associated with an increase in the quantity of another factor of production so that the same level of production may be maintained.
2. **ISO-Product Curves are Convex to the Origin:** ISO-product curve are convex to the origin because the input factors are not perfect substitutes. One input factor can be substituted by other input factor in a diminishing marginal rate.
3. **ISO-Product Curves cannot Intersect Each Other:** ISO-product curves cannot intersect each other because all the ISO-product curves represent different levels of production.

4. **ISO-Product Curves don't touch neither X-axis nor Y-axis:** ISO-Product Curves touch neither X-axis nor Y-axis, as both inputs are required to produce a given level of output.

Marginal Rate of Technical Substitution (MRTS): The MRTS measures the rate at which one input can be substituted for the other while keeping output constant. It is the slope of the isoquant curve and represents the trade-off between the two inputs.

Marginal rate of technical substitution of labour for capital = slope = $\Delta K/\Delta L$

Factor Combinations	*Units of Labour (L)*	*Units of Capital (K)*	*MRTS of L for K*
A	1	12	
			4
B	2	8	
			3
C	3	5	
			2
D	4	3	
			1
E	5	2	

ISOCOSTS

An **isocost line** is a graph showing various possible combinations of inputs (labor and capital) that can be purchased for an estimated total cost. Any combination of inputs on an isocost line provides the same total cost for the output.

Iso-cost lines represent the prices of factors. An iso-cost line graphically represents all the combinations of the inputs which the firm can achieve with a given budget for production or given outlay.

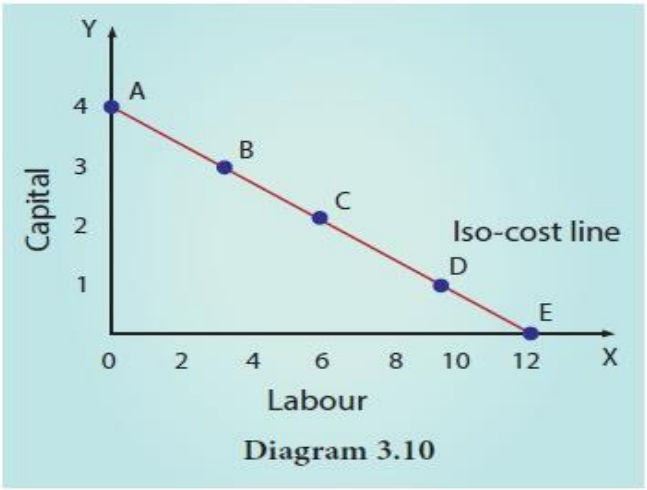
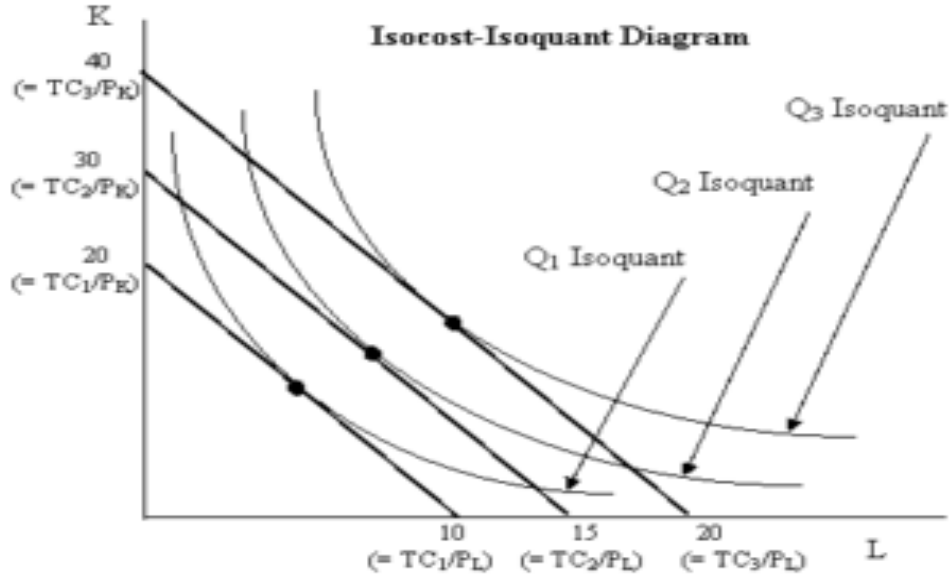


Diagram 3.10

Least cost combination of inputs

Isocosts and Isoquants can together help us to determine the optimum production for a firm. We can achieve production optimisation in two ways. Either we can maximize the production for a given outlay or we can minimize the cost of producing a given level of output.

In case a firm has decided to achieve a given level of production, the next step would be to choose the combination of factors to achieve this target. Definitely, a rational firm would choose the least cost combination. This least cost combination is found out by superimposing the iso-quant on the iso-cost line.



We define the least-cost combinations for three different iso-quants show above at a point where the isocosts are tangential to the isoquants. Evidently, the least cost combination for a given isoquant is at the point of tangency of the isoquant with the isocost line.

Expansion path

An expansion path is a curve that shows the optimal combination of inputs required to produce different levels of output as a business expands production. It's also known as a scale line.

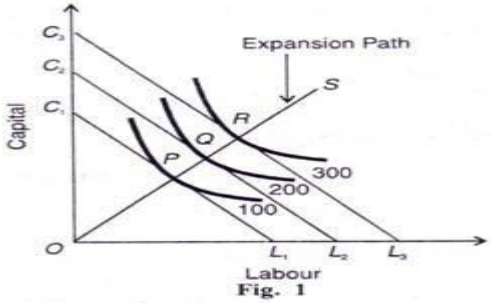


Fig. 1

Cobb-Douglas Production Function

The Cobb-Douglas Production Function was developed by Charles W. Cobb and Paul H. Douglas, based on their empirical study of American manufacturing industry

Cobb -Douglas Production Function is a specific standard equation applied to describe how much output can be made with capital and labour inputs. It is used in empirical studies of manufacturing industries and in inter-industry comparisons. The relative shares of labour and capital in total output can also be determined. It is still used in the analysis of economies of modern, developed and stable nations in the world

Q=AK^aL^b, where K is capital, and L is labor

Returns To Scale

In the long- run, there is no fixed factor; all factors are variable. The laws of returns to scale explain the relationship between output and the scale of inputs in the long-run when all the inputs are increased in the same proportion.

Three Phases of Returns to Scale

1. Increasing Returns to Scale:

In this case if all inputs are increased by one per cent, output increase by more than one per cent.

2. Constant Returns to Scale:

In this case if all inputs are increased by one per cent, output increases exactly by one per cent.

3. Diminishing Returns to Scale:

In this case if all inputs are increased by one per cent, output increases by less than one per cent.

Stages	Input	Output	Returns to Scale
a to b	100% ↑	200% ↑	Increasing
b to c	100% ↑	100% ↑	Constant
c to d	100% ↑	33.33% ↑	Decreasing

The law of increasing returns to scale is implied by the movement from the point ***a*** to point ***b.*** Because, between these two points inputs have doubled and output has more than doubled.

The law of constant returns to scale is implied by the movement from the point ***b*** to point ***c***. Because, between these two points inputs have doubled and output also has doubled.

Decreasing returns to scale are denoted by the movement from the point **c** to point **d** since doubling the factors from 4 units to 8 units produce less than the increase in inputs, that is, by only 33.33%.

COST ANALYSIS

The concept of cost in economics refers to the total expenditure a firm incurs when utilizing economic resources to produce goods and services
In other words concept of cost in economics is a key concept that refers to the amount of money spent to acquire goods and services. It's a financial valuation of the resources, materials, time, risks, and utilities that are consumed to purchase goods and services

Cost analysis, also known as cost-benefit analysis, is the process of calculating the potential earnings from a situation or project and subtracting the total cost associated with completing it. It predicts the profit gained from a project and compares the project's cost to its estimated financial benefits.

Total Cost or TC = TFC + TVC

Types of costs

- Actual cost: The actual expenditure incurred on producing goods and services, such as the value of raw materials, wages, rent, salaries, and interest on borrowed capital
- Opportunity cost: The benefits that are forgone by choosing one alternative over another. For example, if the inputs used to manufacture a

car could also be used to produce military equipment, the opportunity cost is the value of the military equipment that could have been produced

- Explicit cost: A direct expense that is paid in money to others or creditors during the production of goods. This includes costs associated with raw materials, labor wages, packaging, and transportation
- Implicit cost: The factor of production sacrificed by the producer for an alternative factor production. These costs are also known as opportunity costs
- Fixed cost: A cost that is not a function of the output
- Variable cost: A cost that changes over time
- Marginal cost: The addition to total cost when an additional unit of output is produced
- Accounting Costs: Accounting costs are those costs that a firm actually incurs. These costs are explicit costs. There is an actual expenditure which is kept in records for future reference.
- A sunk cost refers to money that has already been spent and cannot be recovered
- Incremental cost is the total cost incurred due to an additional unit of product being produced. Incremental cost is calculated by analyzing the additional expenses involved in the production process, such as raw materials, for one additional unit of production.
- Short-Run and Long-Run Costs:Short-run Costs are costs that vary with output or sales when fixed plant and capital equipment remain the same.Long-run Costs are those which vary with output when all output factors including plant and equipment vary.

- Direct and Indirect Costs A Direct or Traceable Cost is one which can be identified easily and indisputably with a unit of operation, i.e., costing unit/cost centre. Indirect or Common Costs are not traceable to any plant, department or operation as well as those that are not traceable to indirect final products.

- Historical Costs and Replacement Costs:Historical Costs Mean the cost of an asset or the price originally paid for it. Replacement cost means the price that would have to be paid currently for acquiring the same plant
- Controllable and Non-Controllable Costs:A Controllable Cost is one which is reasonably subject to regulation by the executive with whose responsibility that cost is being identified.Un-controllable cost is that cost which is uncontrollable at one level of responsibility may be regarded as controllable at some other higher level. The controllability of certain costs may be shared by two or more executives. The distinction is important for controlling the expenses and efficiency.

- Semi Fixed- Semi Variable Cost: Semi-fixed and semi variable costs are those costs which remain constant up to a certain level of output and then start increasing proportionately. These costs arise where there is no clear identification of the cost i.e. whether it is a fixed cost or a variable cost. Eg. Electricity charges and telephone charges as they are fixed up to a certain limit and then they vary according to the used units.

Cost-Output Relation in the short-run:: The cost concepts made use of in the cost behavior are total cost, Average cost, and marginal cost. Total cost is the actual money spent to produce a particular quantity of output. Total cost is the summation of fixed and variable costs.

$$TC=TFC+TVC$$

Up to a certain level of production total fixed cost i.e., the cost of plant, building, equipment etc, remains fixed. But the total variable cost i.e., the cost of labour, raw materials etc., Vary with the variation in output. Average cost is the total cost per unit. It can be found out as follows.

$$AC= TC /Q$$

The total of average fixed cost (TFC/Q) keep coming down as the production is increased and average variable cost (TVC/Q) will remain constant at any level of output.

Marginal cost is the addition to the total cost due to the production of an additional unit of product. It can be arrived at by dividing the change in total cost by the change in total output.

In the short-run there will not be any change in total fixed cost. Hence change in total cost implies change in total variable cost only.

Output	TFC	TVC	TC	AVC	AFC	ATC	MC
0	60		60	-	-	-	-
1	60	20	80	20	60	80	20
2	60	36	96	18	30	48	16
3	60	48	108	16	20	36	12
4	60	64	124	16	15	31	16
5	60	90	150	18	12	30	26
6	60	132	192	22	10	32	42

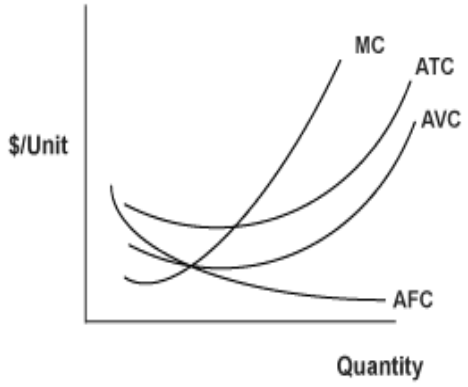
The above table represents the cost-output relation. The table is prepared on the basis of the law of diminishing marginal returns.

The fixed cost Rs. 60 May include rent of factory building, interest on capital, salaries of permanently employed staff, insurance etc. The table shows that fixed cost is same at all levels of output but the average fixed cost, i.e., the fixed cost per unit, falls continuously as the output increases.

The expenditure on the variable factors (TVC) is at different rate. If more and more units are produced with a given physical capacity the AVC will fall initially, as per the table declining up to 3rd unit, and being constant up to 4th unit and then rising.

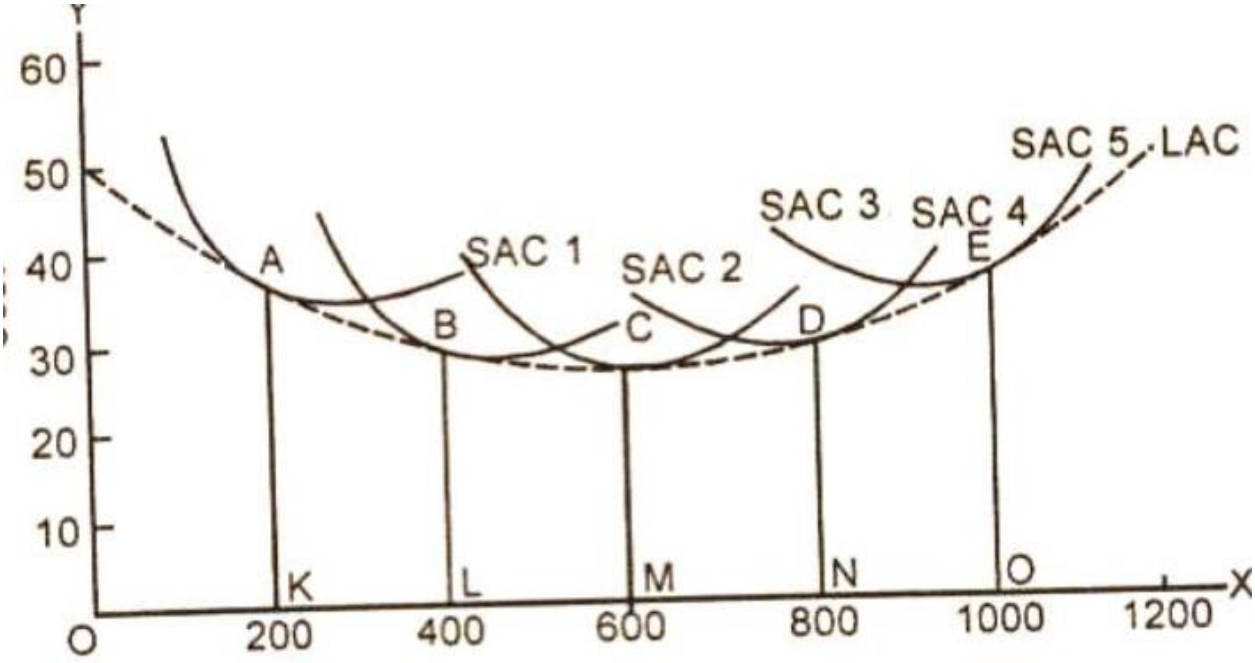
The total cost (TC) increases with volume of production and ATC will decreases up to a certain level of production and then rising.

The Marginal cost will decreases up to a certain level of production and then rising.



In the graph, the output goes on increasing, AFC will continue to decrease. Hence , AFC curve will slope downwards and it appear to meet the X axis but it will never meet the X axis for obvious reason. The AVC is a U-shaped curve denoting that the AVC curve tends to fall in the beginning when the output is increasing but after a particular level of output, it rises because of the application of Law of variable proportion. Average total(ATC) cost is the sum of AVC and AFC. As output increases and AFC decreases, the influence of AFC on ATC also will decline. The marginal cost curve is also a U shaped curve. It falls in the beginning and rises sharply.

- **Cost-output Relationship in the long-run:** Long run is a period, during which all inputs are variable .The long run enables the firms to expand and scale of their operation by bringing or purchasing larger quantities of all the inputs. Thus in the long run all factors become variable. The long-run cost-output relations therefore imply the relationship between the total cost and the total output. In the long-run cost-output relationship is influenced by the law of returns to scale.



To draw on ‘LAC’ curve we have to start with a number of ‘SAC’ curves. Suppose the firm is producing an output of 200 units on plant of SAC1. If it wants to produce 400 units of output, either it can operate on SAC1 or by acquiring a bigger size plant of SAC2. It will be less costly to operate on SAC2. If it wants to produce 600 units of output, it can operate on the bigger size plant SAC3 at least cost.

It is to be noted that there is only one short run cost curve SAC3 which is tangential to the long run average cost curve at its minimum point. All other SAC curves are tangential to the LAC curve at higher than their minimum average cost points.