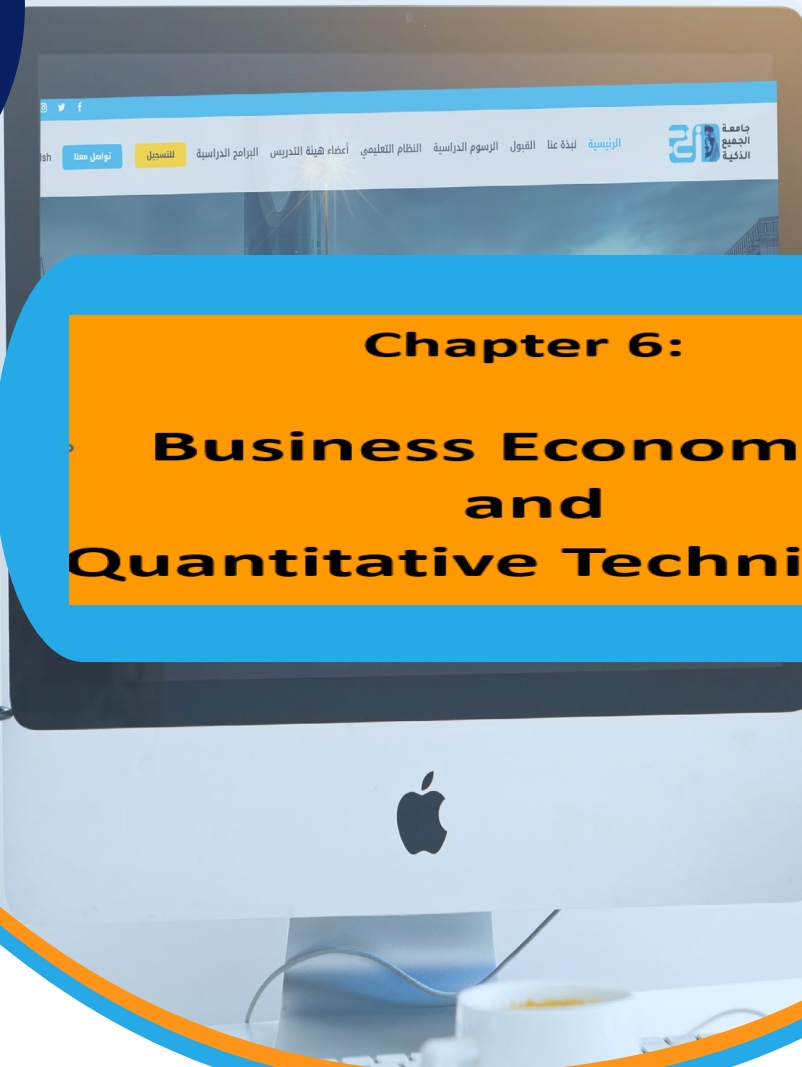


# MGM 112

## Introduction to Economics

Prepared by Dr. Maryem ZORGUI



### Chapter 6:

## Business Economics and Quantitative Techniques

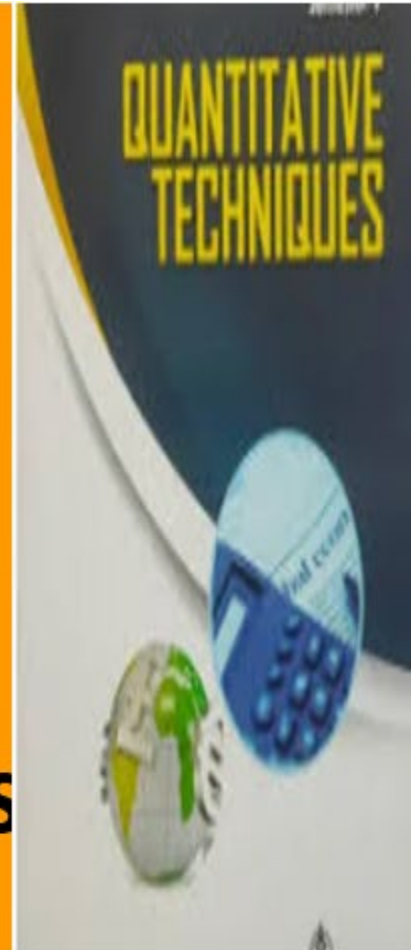


جامعة الجميع الذكية  
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# Lecture 6



## Chapter 6: Business Economics and Quantitative Techniques



# Syllabus

**I- The Production Function  
in Short and Long Run**

**II-Law of variable proportion  
=  
Short run production function.**

## **I- The Production Function in Short and Long Run**

**I-1- The Production Function**

**I-2- Production with one variable input  
(Labour)**

**I-3- Production with one two variable inputs  
(Labour and Capital)**

# I- The Production Function in Short and Long Run

## I-1- The Production Function

- Production functions describe what is technically feasible when the firm operates efficiently.
- Production function shows the highest output that a firm can produce for every specified combination of inputs.

# I- The Production Function in Short and Long Run

The Production Function:

$$q = F(K, L)$$

Where :

- q** is the **output quantity**,
- L** is the **labour used**, and
- K** is the **capital invested** for the production of the goods.

# I- The Production Function in Short and Long Run

## Factors of Production (Factor Inputs)

Factors of production are the inputs available to supply goods and services in an economy.

Natural resources available for production

**Land**

The human input into the production process

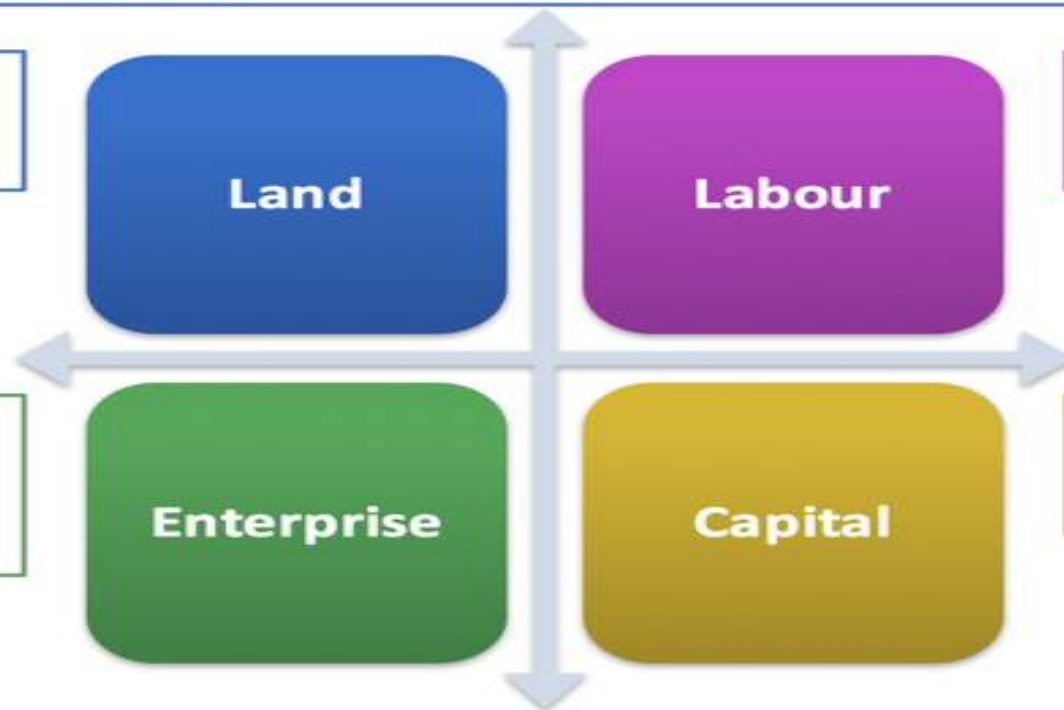
**Labour**

Entrepreneurs organise factors of production and take risks

**Enterprise**

Goods used in the supply of other products e.g. tech

**Capital**



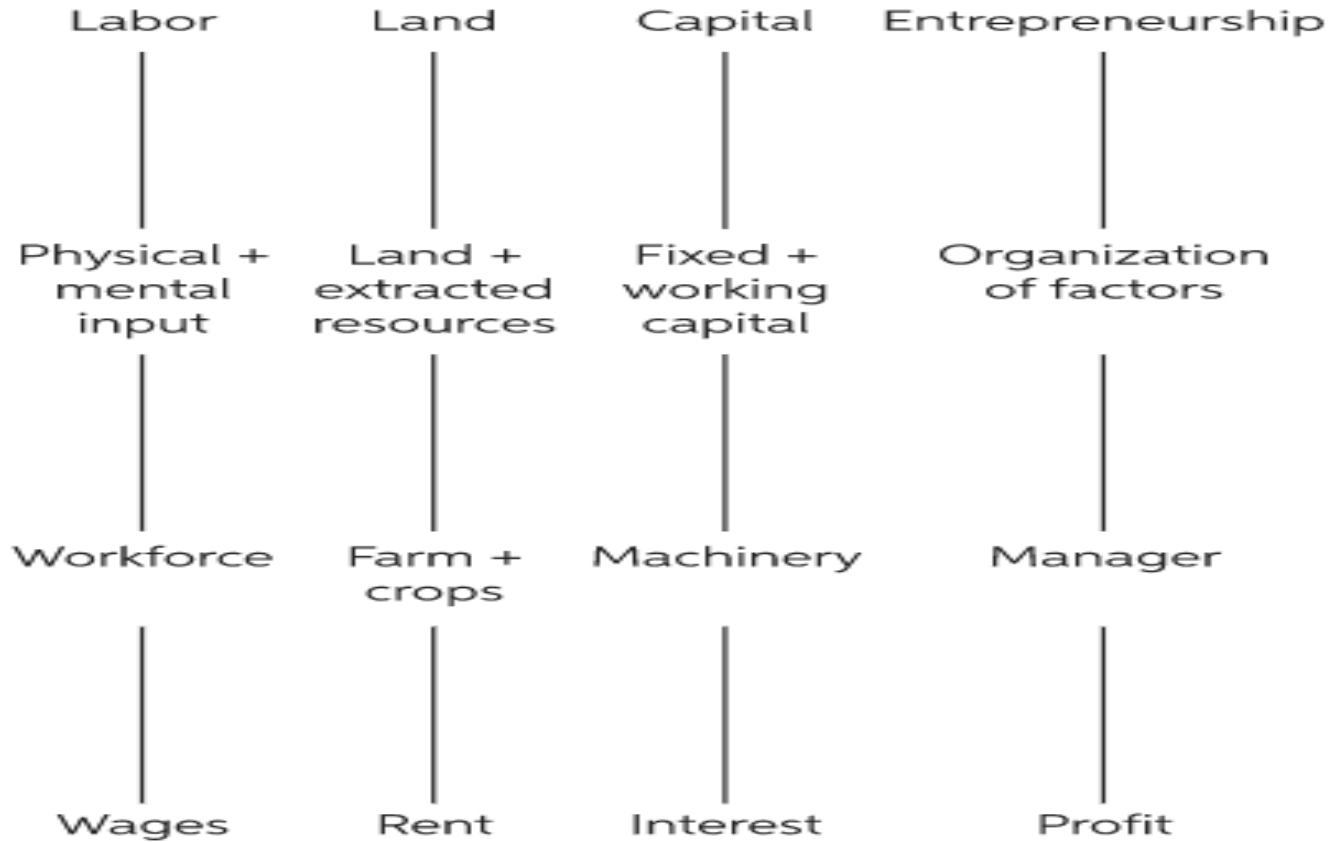
# I- The Production Function in Short and Long Run

FACTORS

CHARACTERISTICS

EXAMPLES

REWARDS



# I- The Production Function in Short and Long Run

## A- The Production Decisions of a Firm

- **The Production decisions** of firms are analogous to the purchasing decisions of consumers, and can likewise be understood in three steps:

**1. Production Technology**

**2. Cost Constraints**

**3. Input Choices**

# I- The Production Function in Short and Long Run

## B- The Short Run versus the Long Run

- **Short run** is period of time in which quantities of **one or more** production factors cannot be changed.
  - We have at least one fixed input Production Factor that **cannot be varied**.
- **Long run** is the amount of time needed to make **all production inputs variable**.

# I- The Production Function in Short and Long Run

## I-2- Production with one variable Input ( Labour)

- A producer may affect changes in his production by changing only the variable factor, other factors and technology remaining constant.
- The **proportional relationship** between **production** and **variable factors of production** is termed as **return to factor**.
- **Initially**, production with one variable input (labour) follows **the law of increasing returns**.
- According to this law, output would increase at an increasing rate as the quantity of labour increases.
- The output would increase at a diminishing rate as labour is used more and more.

# I- The Production Function in Short and Long Run

## I-2- a-Total, Average and Marginal Products

### Total Product (TP)

- Total quantity of output produce with a given quantity of input.
- $\text{Total Product} = \text{Average Product} \times \text{Total Variable Input}$

### Average Product (AP)

- Ratio of total production to total variable inputs (labour) used to produce a product.
- $\text{Average Product} = \text{Total Product} / \text{Total Variable Input}$

### Marginal Product (MP)

- The change in total production when variable inputs are increased in increments of one unit.
- $\text{Marginal product} = \text{change in TP} / \text{change in Total Variable Input}$

# PRODUCTION WITH ONE VARIABLE INPUT (LABOR)

**TABLE 6.1 Production with One Variable Input**

| Amount of Labor ( $L$ ) | Amount of Capital ( $K$ ) | Total Output ( $q$ ) | Average Product ( $q/L$ ) | Marginal Product ( $\Delta q/\Delta L$ ) |
|-------------------------|---------------------------|----------------------|---------------------------|------------------------------------------|
| 0                       | 10                        | 0                    | —                         | —                                        |
| 1                       | 10                        | 10                   | 10                        | 10                                       |
| 2                       | 10                        | 30                   | 15                        | 20                                       |
| 3                       | 10                        | 60                   | 20                        | 30                                       |
| 4                       | 10                        | 80                   | 20                        | 20                                       |
| 5                       | 10                        | 95                   | 19                        | 15                                       |
| 6                       | 10                        | 108                  | 18                        | 13                                       |
| 7                       | 10                        | 112                  | 16                        | 4                                        |
| 8                       | 10                        | 112                  | 14                        | 0                                        |
| 9                       | 10                        | 108                  | 12                        | -4                                       |
| 10                      | 10                        | 100                  | 10                        | -8                                       |

## Production Function with One Variable Input

Total Product  $TP = Q = f(L)$

Marginal Product  $MP_L = \frac{\Delta TP}{\Delta L}$

Average Product  $AP_L = \frac{TP}{L}$

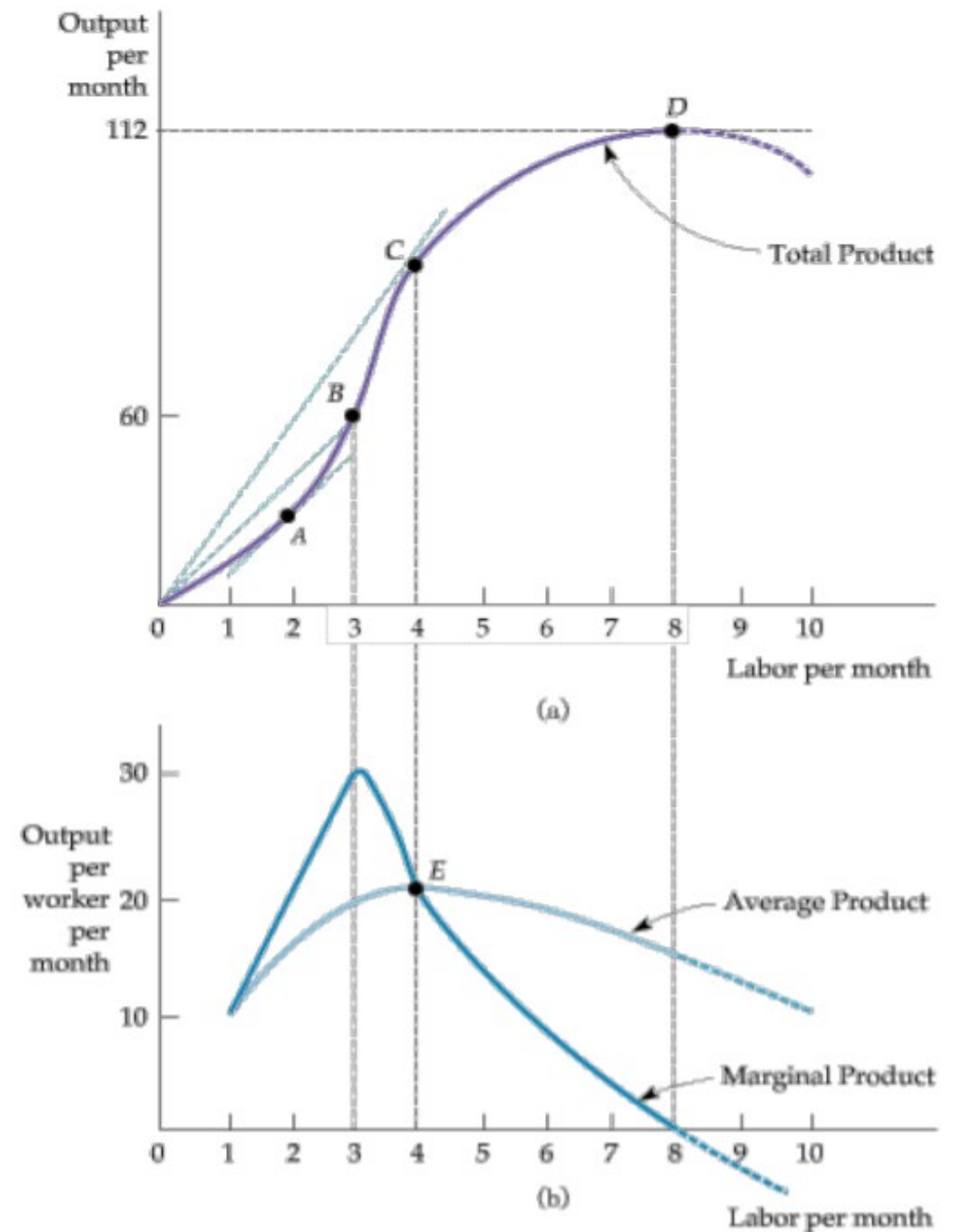
Production or Output Elasticity  $E_L = \frac{MP_L}{AP_L}$

## Lecture 6

# I- The Production Function in Short and Long Run

### I-2- b-The Slopes of the Product Curve

- The total product curve in (a) shows the output produced for different amounts of labor input.
- The average and marginal products in (b) can be obtained (using the data in Table 6.1) from the total product curve.
- At point A in (a), the marginal product is 20 because the tangent to the total product curve has a slope of 20.
- At point B in (a) the average product of labor is 20, which is the slope of the line from the origin to B.
- The average product of labor at point C in (a) is given by the slope of the line OC

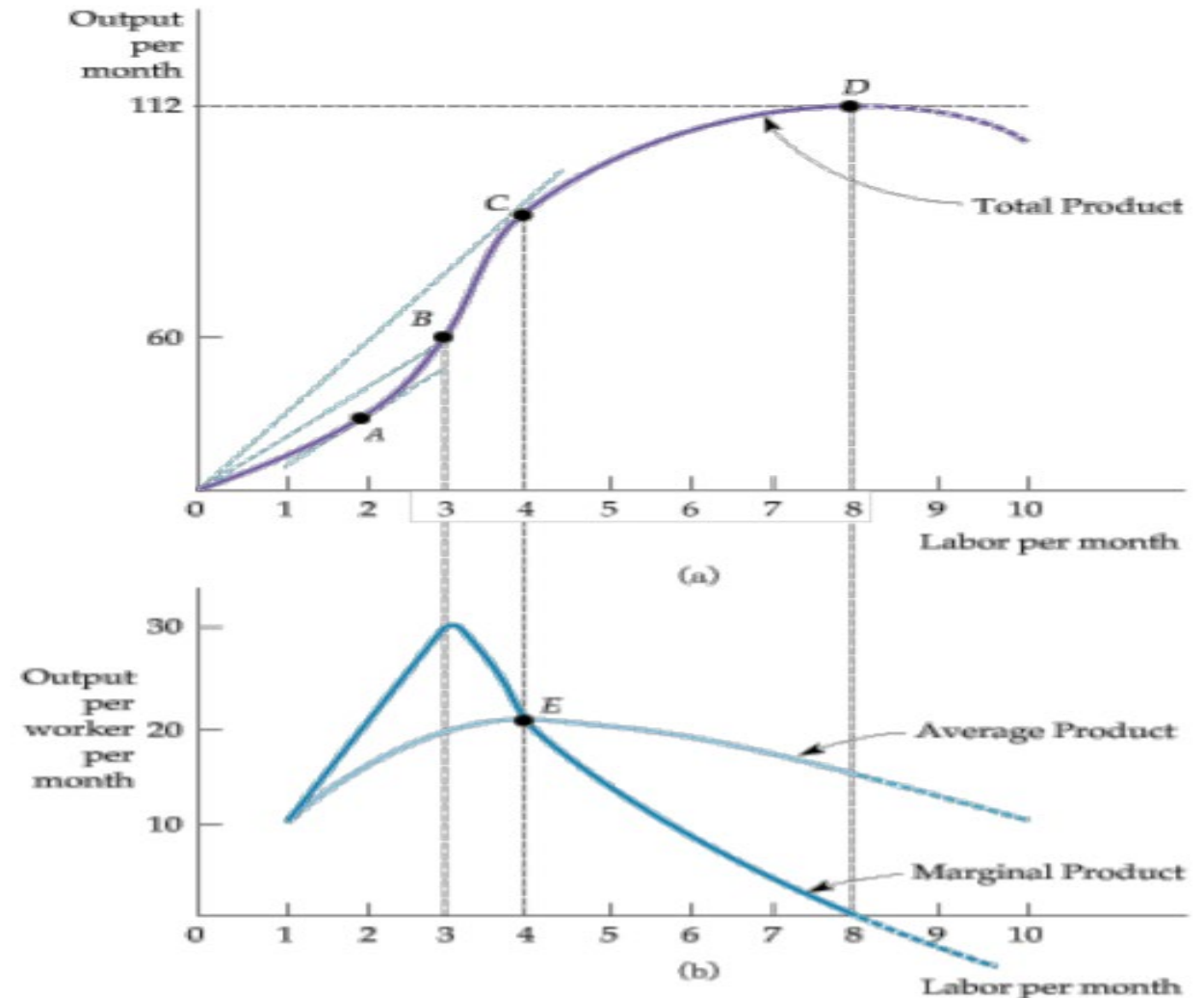


## Lecture 6

# I- PRODUCTION WITH ONE VARIABLE INPUT (LABOUR)

To the left of point E in (b), the marginal product is above the average product and the average is increasing; to the right of E, the marginal product is below the average product and the average is decreasing.

As a result, E represents the point at which the average and marginal products are equal, when the average product reaches its maximum. At D, when total output is maximized, the slope of the tangent to the total product curve is 0, as is the marginal product.



## I- PRODUCTION WITH ONE VARIABLE INPUT (LABOUR)

### I-2- c-The Law of Diminishing Marginal Returns

**Law of diminishing marginal returns** is a principle that as the use of an input increases with other inputs fixed, the resulting additions to output will eventually decrease.

# PRODUCTION WITH ONE VARIABLE INPUT (LABOR)

## ◆ The Law of Diminishing Marginal Returns

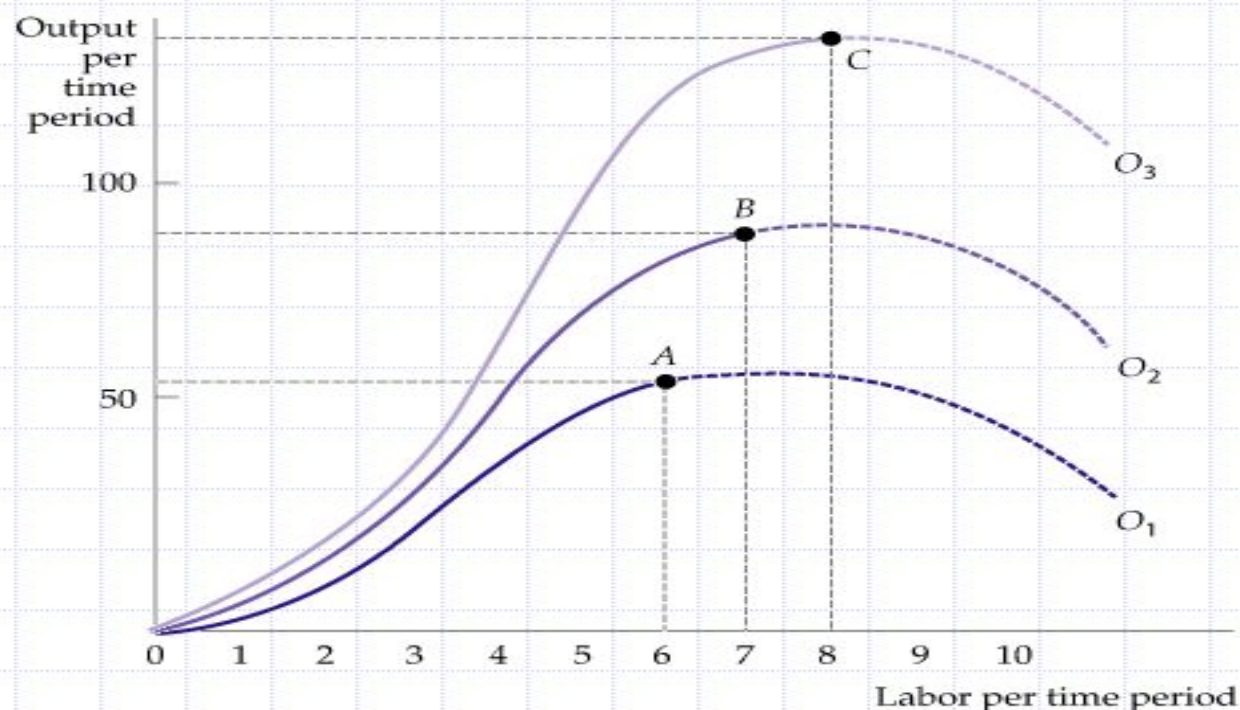
- **law of diminishing marginal returns** Principle that as the use of an input increases with other inputs fixed, the resulting additions to output will eventually decrease.

Figure 6.2

### The Effect of Technological Improvement

Labor productivity (output per unit of labor) can increase if there are improvements in technology, even though any given production process exhibits diminishing returns to labor.

As we move from point A on curve  $O_1$  to B on curve  $O_2$  to C on curve  $O_3$  over time, labor productivity increases.



# I- The Production Function in Short and Long Run

## I-2- d- Labour Productivity

**The Labour Productivity** = the Average product of labor for an entire industry or for the economy as a whole.

 **Productivity and the Standard of Living** is the:

- **stock of capital** or the total amount of capital available for use in production.
- the **technological change development of new technologies** allowing factors of production to be used **more effectively**.

# I- The Production Function in Short and Long Run

## I-2- e- The law of diminishing marginal productivity

- **The law of diminishing marginal productivity** is an economic principle usually considered by managers in **productivity management**.
- Generally, it states that **advantages** gained from slight improvement on the input side of the production equation will only **advance marginally per unit** and may level off or even decrease after a specific point.

## **I- The Production Function in Short and Long Run**

### **I-1- The Production Function**

#### **I-2- Production with one variable Input (Labour)**

#### **I-3- Production with 2 variables Inputs (Labour and Capital)**

## II- Production Functions with Two Variable Factors and the Isoquants

- For the analysis of production function with two variable factors we make use of the concept called **isoquants** or **iso-product curves** which are similar to indifference curves of the theory of demand.

 Therefore, before we explain the production function with two variable factors and **returns to scale**, we shall explain the concept of **isoquants** (that is, equal product curves) and their properties.

## II- Production Functions with Two Variable Factors and the Isoquants

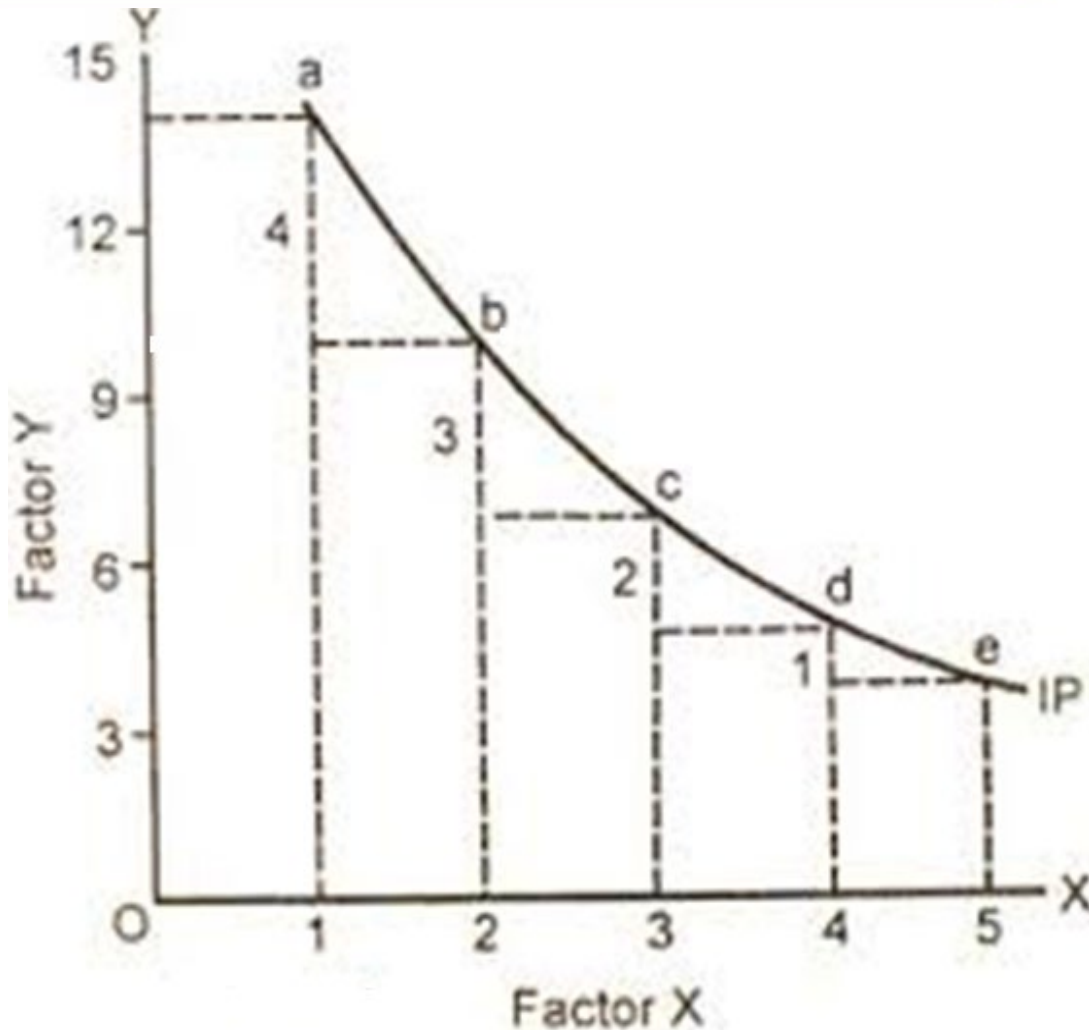
### I-4- Isoquants:

- **Isoquants**, which are also called **equal product curves**, are similar to the indifference curves of the theory of consumer's behaviour. An isoquant represents all those factor combinations which are capable of producing the same level of output.
- The isoquants are thus contour lines which trace the loci of equal outputs. Since an isoquant represents those combinations of inputs which will be capable of producing an equal quantity of output, the producer would be indifferent between them. Therefore, isoquants are also often called equal product curves production-indifference curves.

## II- Production Functions with Two Variable Factors and the Isoquants

### Isoquants

Isoquants shows the different combination of **labour** and **capital** to produce the same level of output.



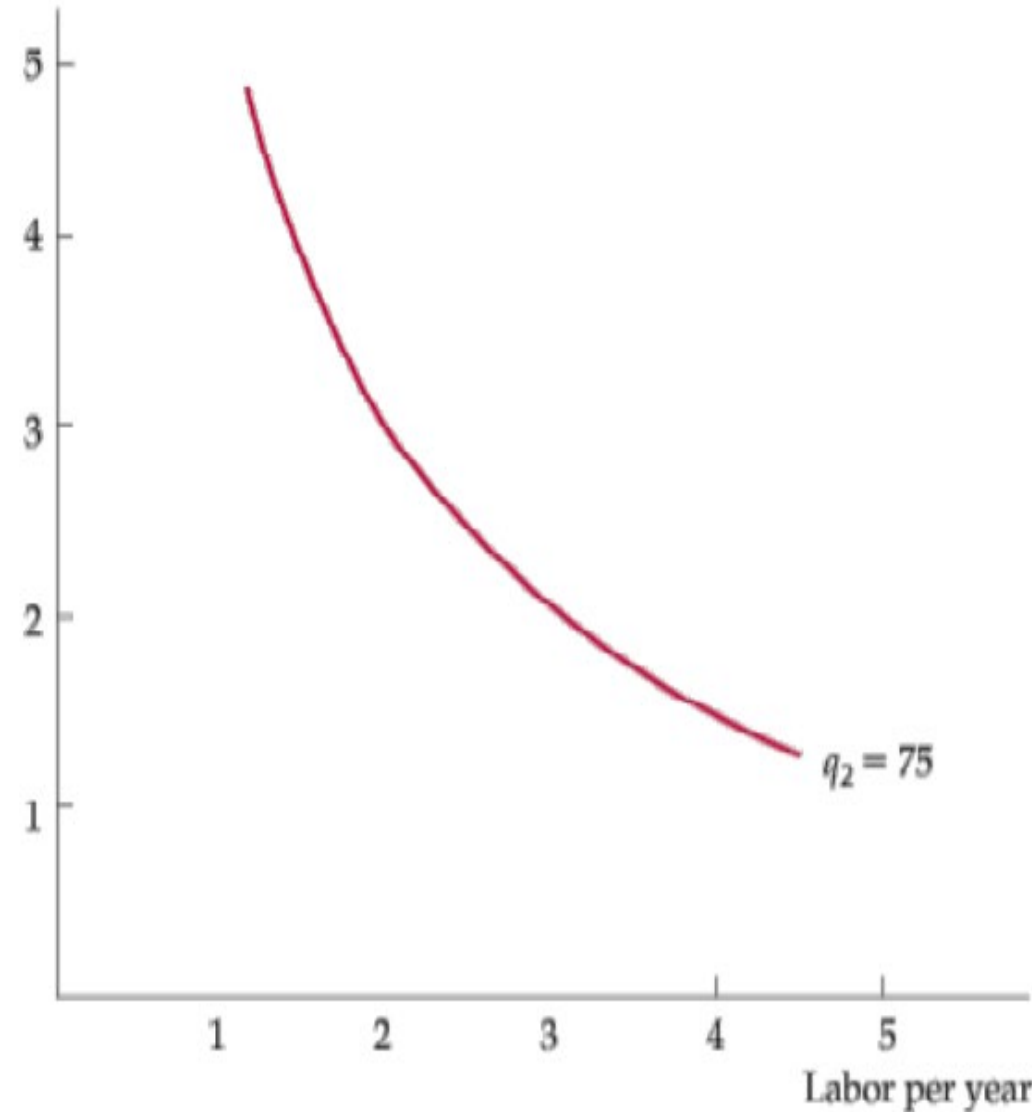
## Properties of Iso-quant

1. An Iso-Quant curve like a an indifference curve is a downward sloping curve towards the right
2. A Higher Iso-Quant represents large output
3. No two Iso-Quant can intersect each other
4. Iso-Quant are convex to the origin
5. In between two iso-quant there may be number of iso-quant
6. Units of output shown on iso-quant are purely arbitrary

**TABLE 6.4 Production with Two Variable Inputs****LABOR INPUT**

| Capital Input | 1  | 2  | 3   | 4   | 5   |
|---------------|----|----|-----|-----|-----|
| 1             | 20 | 40 | 55  | 65  | 75  |
| 2             | 40 | 60 | 75  | 85  | 90  |
| 3             | 55 | 75 | 90  | 100 | 105 |
| 4             | 65 | 85 | 100 | 110 | 115 |
| 5             | 75 | 90 | 105 | 115 | 120 |

**isoquant** Curve showing all possible combinations of inputs that yield the same output.

Capital  
per  
year

# Isoquants

- **isoquant map** Graph combining a number of isoquants, used to describe a production function.

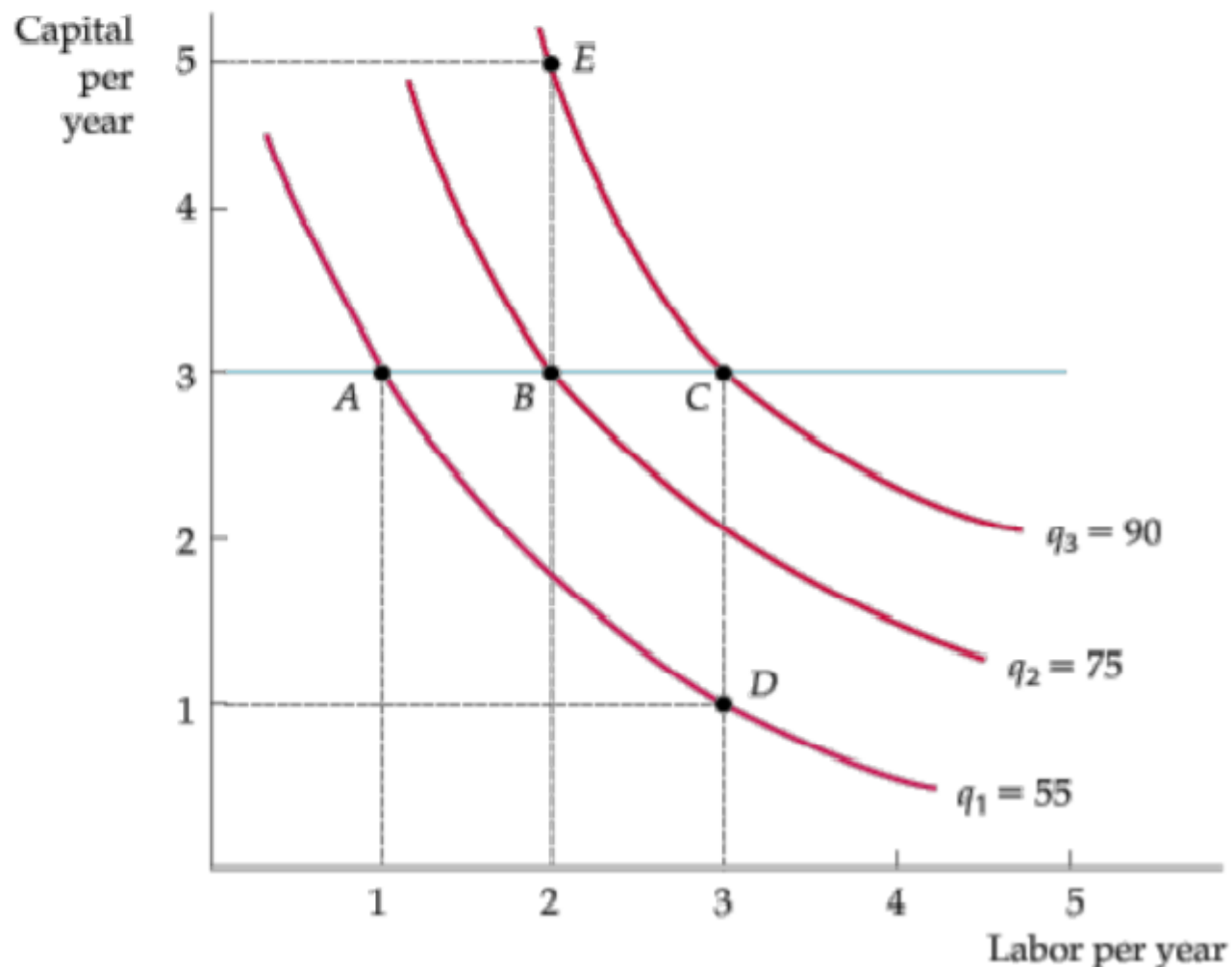
## Production with Two Variable Inputs

A set of isoquants, or *isoquant map*, describes the firm's production function.

Output increases as we move from isoquant  $q_1$  (at which 55 units per year are produced at points such as  $A$  and  $D$ ),

to isoquant  $q_2$  (75 units per year at points such as  $B$ ) and

to isoquant  $q_3$  (90 units per year at points such as  $C$  and  $E$ ).



Graph:

Isoquant  
Curve Map

## **II- Law of Variable Proportion = Short run Production Function**

### **II-1- Definition**

### **II-2- Assumptions of the Law of Variable Proportion**

## II- Law of variable proportion or short run production function

### II-1- Definition

- This law is also called **the law of Proportionality**.
- The law state that change in output due to the change in any one input by the same rate.
- Leftwitch: *“the law of variable proportion states that if the inputs of one resource is increased by equal increment per unit of time while the inputs of other resources are held constant, total output will increase, but beyond some point the resulting output increase will become smaller and smaller”*.

## II- Law of variable proportion or short run production function

***"The law of variable proportion states that if a variable quantity of one resource is applied to a fixed amount of other inputs, output per unit of variable input will increase but beyond some point the resulting increase will be less and less and with total output reaching a maximum before it finally begins to decline."***

## II- Law of variable proportion or short run production function

### II-2- Assumptions of the Law of variable proportion

- The law is based on **no change in the technology**.
- All units of the variable factor are **homogenous**.
- **Only one factor is variable**, others remaining constant.
  - ➔ Only applicable under **short run**.
- The products are measured in **physical units**, example: quintals, tones etc.
- It is assumed that **all variable factors** are **equally efficient**.

## II- Law of variable proportion or short run production function

### II-3- The Three Stages of the Law

- The Law of Variable proportions has three stages, which are discussed below.

**1.First Stage**

**2.Second Stage**

**3.Third Stage**

## II- Law of variable proportion or short run production function

### 1- First Stage or Stage of Increasing returns

In this stage, the total product increases at an increasing rate.

This happens because the efficiency of the fixed factors increases with addition of variable inputs to the product.

### 2- Second Stage or Stage of Diminishing Returns

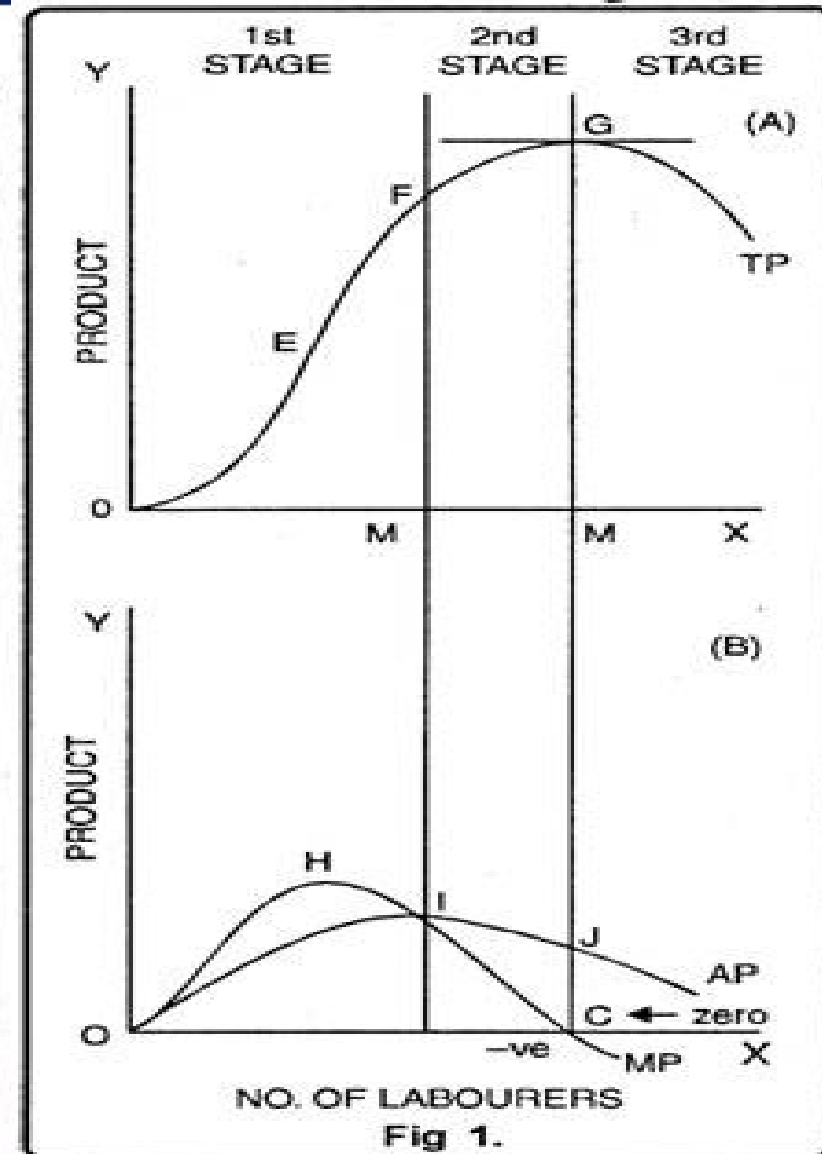
In this stage, the total product increases at a diminishing rate until it reaches the maximum point. The marginal and average product are positive but diminishing gradually.

### 3- Third Stage or Stage of Negative Returns

In this stage, the total product declines and the marginal product becomes negative.

## II- Law of variable proportion or short run production function

| Total Product                                                                     | Marginal Product                                                          | Average Product                                             |
|-----------------------------------------------------------------------------------|---------------------------------------------------------------------------|-------------------------------------------------------------|
| <b>Stage I</b><br>First increases at increasing rate then at diminishing rate.    | Increases in the beginning then reaches a maximum and begins to decrease. | First increases, continues to increase and becomes maximum. |
| <b>Stage II</b><br>Continues to increase at diminishing rate and becomes maximum. | Continues to diminish and becomes equal to zero.                          | Becomes equal to MP and then begins to diminish.            |
| <b>Stage III</b><br>Diminishes                                                    | Becomes negative.                                                         | Continues to diminish but will always be greater than zero. |



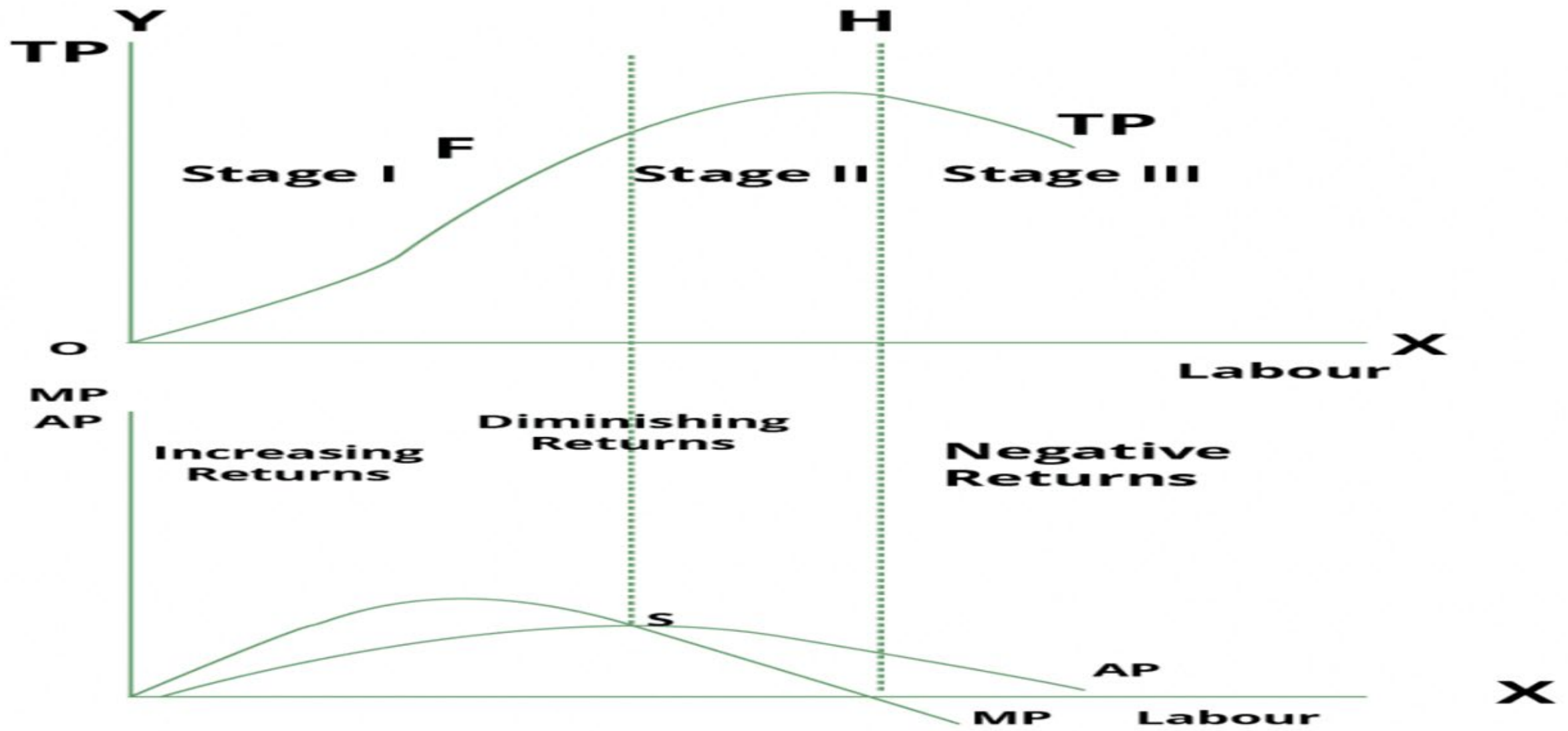
# Lecture 6

## II- Law of variable proportion or short run production function

**Example:**

| Units of variable input | TP | AP= (TP/L) | MP = (dTP/dL) | Stage                                                     |
|-------------------------|----|------------|---------------|-----------------------------------------------------------|
| 1                       | 4  | 4          | 4             | Stage 1<br>MP>AP<br>MP increases more than AP             |
| 2                       | 10 | 5          | 6             |                                                           |
| 3                       | 21 | 7          | 11            |                                                           |
| 4                       | 40 | 10         | 19            |                                                           |
| 5                       | 55 | 11         | 15            | Stage 2<br>MP increases but at slower rate. TP is maximum |
| 6                       | 60 | 10         | 5             |                                                           |
| 7                       | 63 | 9          | 3             |                                                           |
| 8                       | 64 | 8          | 1             |                                                           |
| 9                       | 63 | 7          | -1            | Stage 3<br>MP<0<br>MP declines                            |

**FOR  
EXAMPLE**



**Graph:**  
**Diagrammatic representation- Law of variable proportion**

# Graphical Representation of Three Stage Law of Variable Proportions



## II- Law of variable proportion or short run production function

### III-4- Applicability of the Law of Variable Proportions:

- The **law of variable proportions** is universal as it applies to all fields of production.
- This law applies to any field of production where some factors are fixed and others are variable.
- That is why it is called the law of universal application.

## II- Law of variable proportion or short run production function

- The main cause of application of this law is the fixity of any one factor.
- Land, mines, fisheries, and house building etc. are not the only examples of fixed factors.
- Machines, raw materials may also become fixed in the short period.
- Therefore, this law holds good in all activities of production etc. agriculture, mining, manufacturing industries.

## II- Law of variable proportion or short run production function

- **Application to Agriculture**

With a view of raising agricultural production, labour and capital can be increased to any extent but not the land, being fixed factor. Thus when more and more units of variable factors like labour and capital are applied to a fixed factor then their marginal product starts to diminish and this law becomes operative.

- **Application to Industries**

In order to increase production of manufactured goods, factors of production has to be increased. It can be increased as desired for a long period, being variable factors.

Thus, law of increasing returns operates in industries for a long period. But, this situation arises when additional units of labour, capital and enterprise are of inferior quality or are available at higher cost.

A spiral-bound notepad with a white cover and a metal spiral binding is centered on a light brown wooden surface. The word "SUMMARY!" is written in large, red, hand-drawn capital letters on the notepad's page. The notepad is surrounded by numerous small, colorful clothespins in various colors including red, blue, green, yellow, pink, and purple, scattered across the wooden background.

SUMMARY!

# Production Function

## Short Run

Short period of production – some of the inputs cannot be varied because there is not enough time.

For example: for an employer it is easier to add new labor than new equipment.

Labor is an input factor that can be varied – which impacts production.

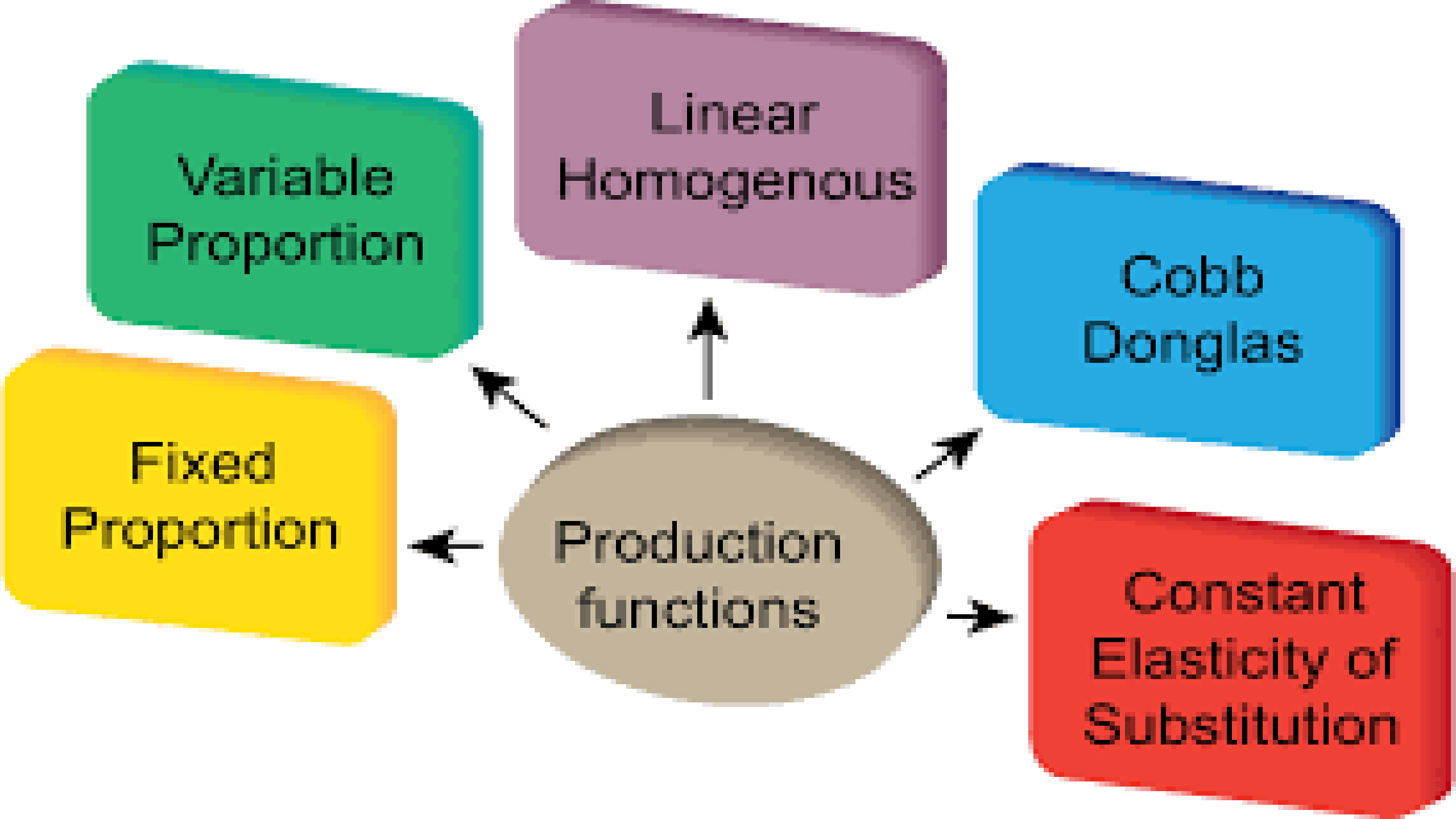
## Long Run

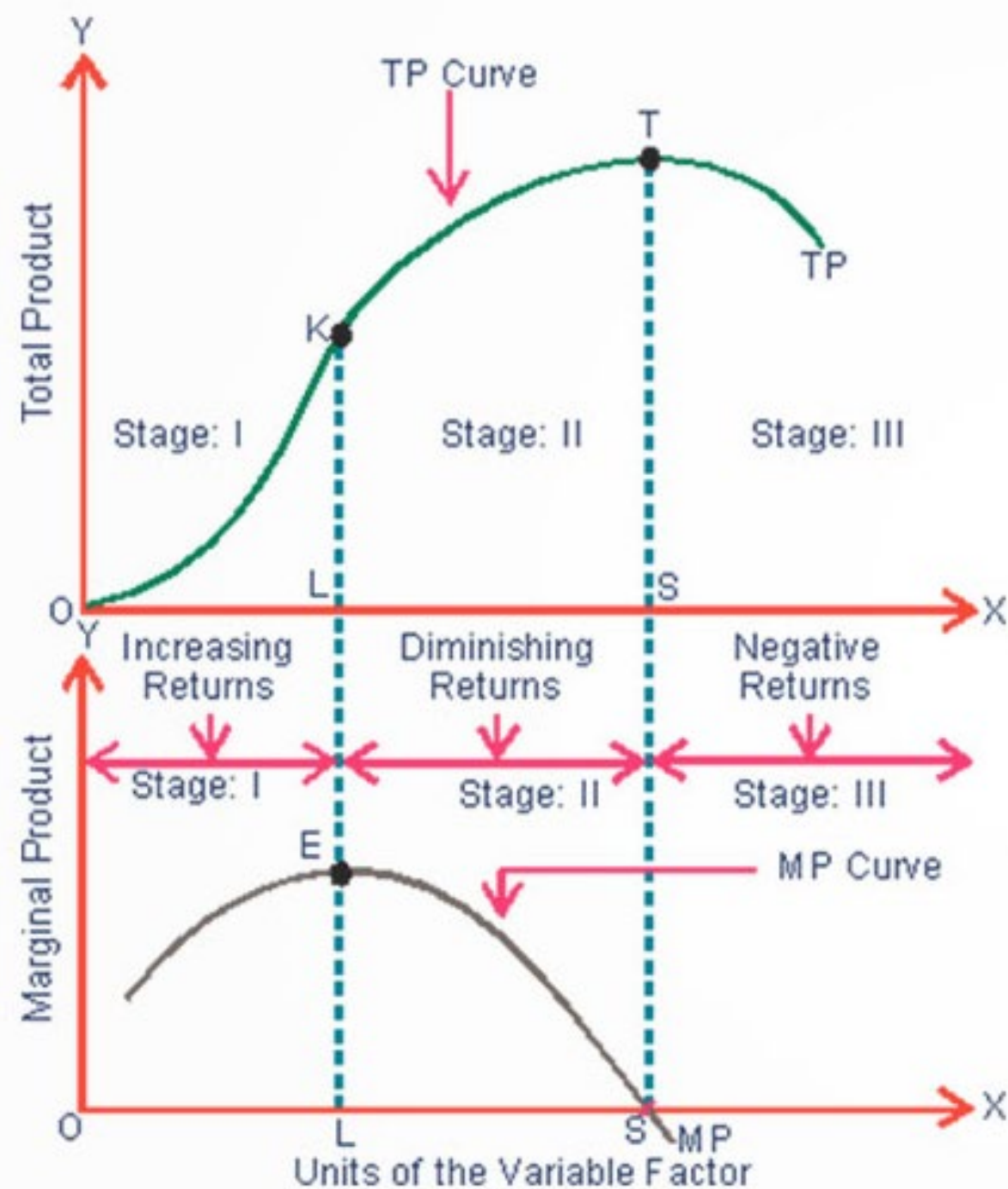
There is enough time in this period of production for managers to vary all the inputs used to make a product – not just labor.

For example: new equipment, as well as labor, can be added to the existing setup to boost production.

*Short Run:  $q = f(L)$*

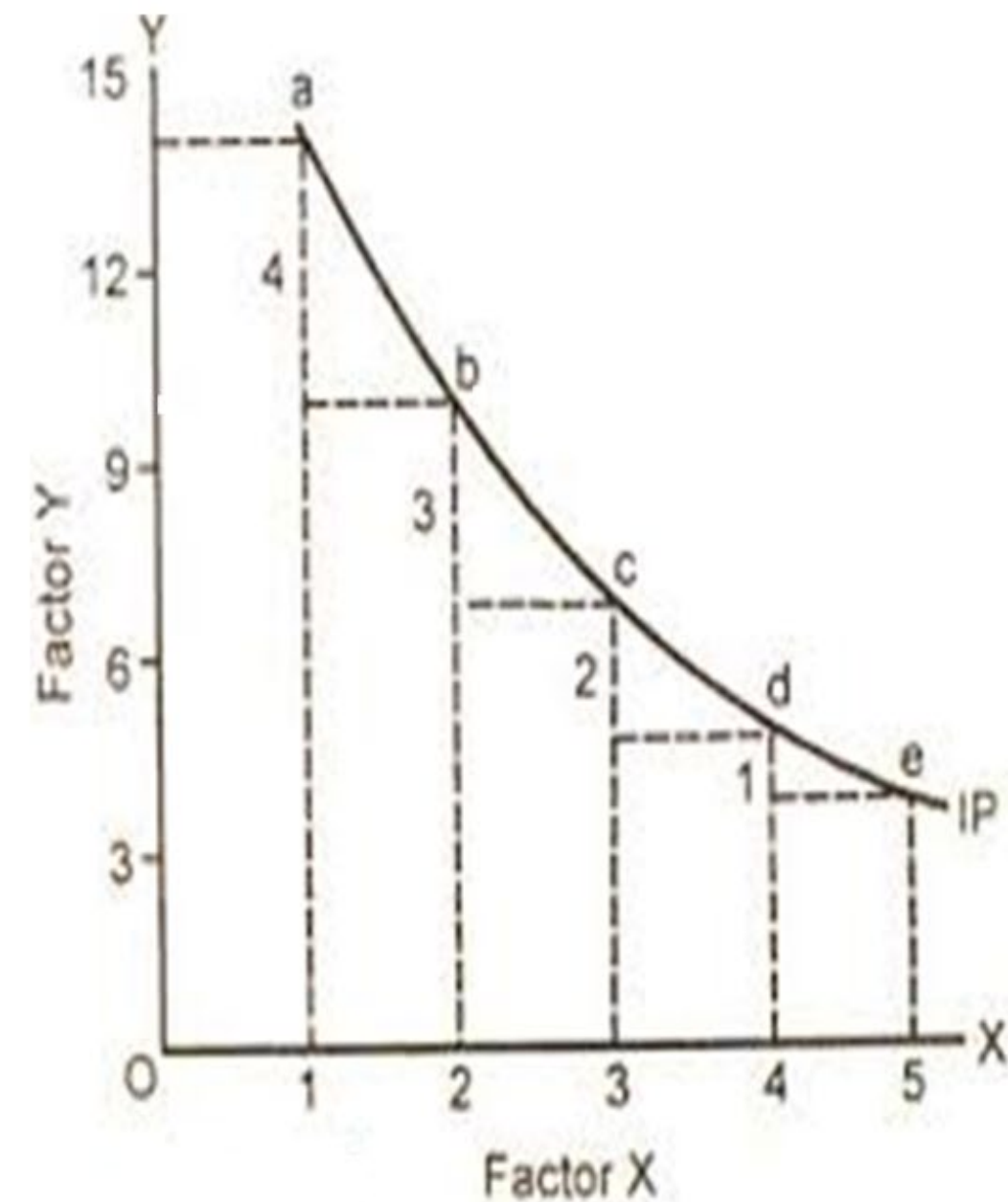
*Long Run:  $q = f(K, L)$*





# Stages Of The **PRODUCTION** In Economics





## Isoquants

- **isoquant map** Graph combining a number of isoquants, used to describe a production function.

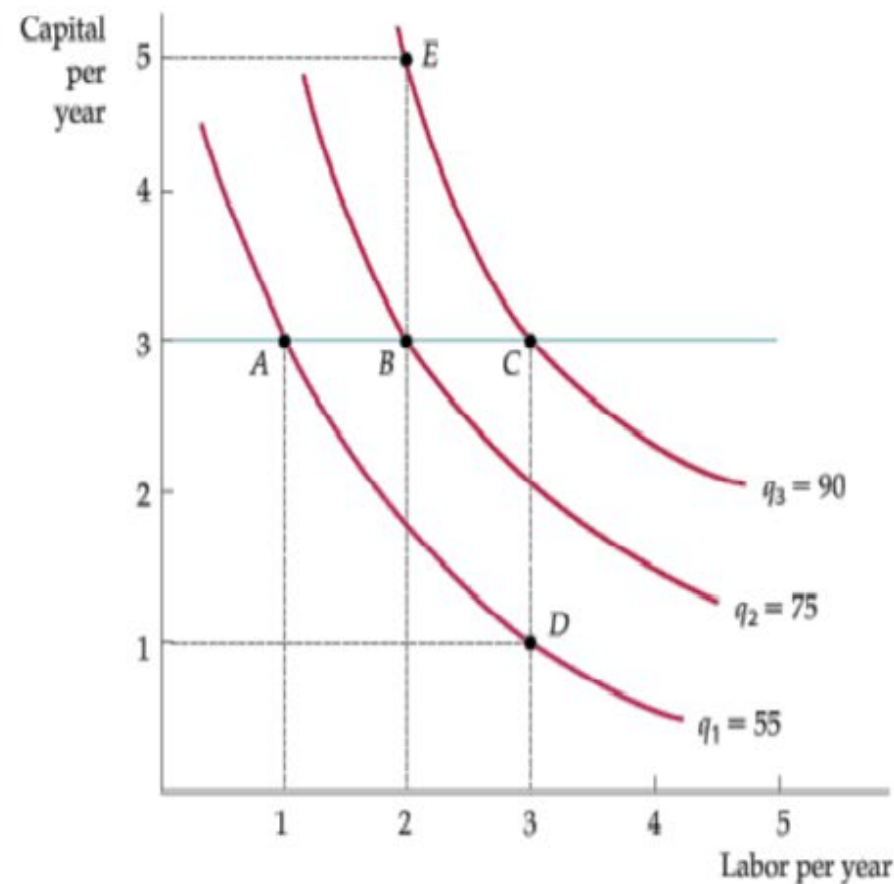
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to isoquant  $q_2$  (75 units per year at points such as B) and

to isoquant  $q_3$  (90 units per year at points such as C and E).



THANK YOU

AND

GOOD BYE