

# **C.S. Azad University of Agriculture & Technology, Kanpur**



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# **Product-Product Relationship**

# Content

- ❖ Product-Product Relationship Meaning
- ❖ Production Possibility Curve (PPC)
- ❖ Types of Product-Product Relationships (Enterprise Relationship)
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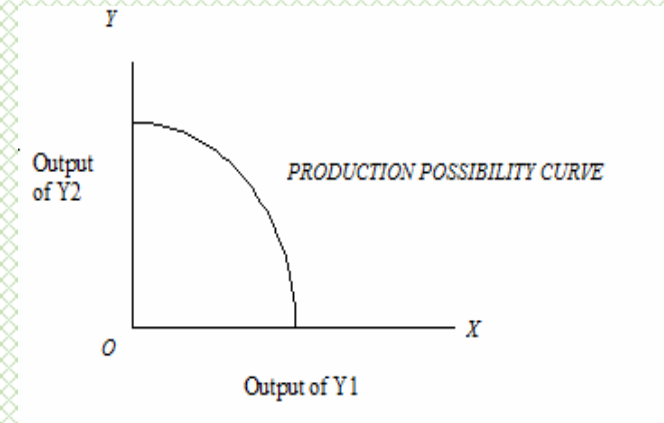
# Product-Product Relationship

- ❖ Product-Product relationship deals with resource allocation among competing enterprises.
- ❖ The goal of Product-Product relationship is **profit maximization**.
- ❖ Under Product-Product relationship, inputs are kept constant while products (outputs) are varied.
- ❖ This relationship guides the producer in deciding '**What to produce**'
- ❖ This relationship is explained by the **principle of product substitution and law of equi-marginal returns**.
- ❖ This relationship is concerned with the determination of optimum combination of products (enterprises).
- ❖ The choice indicators are substitution ratio and price ratio.
- ❖ Algebraically it is expressed as

$$Y_1 = f(Y_2, Y_3, \dots, Y_n)$$

# Production Possibility Curve (PPC)

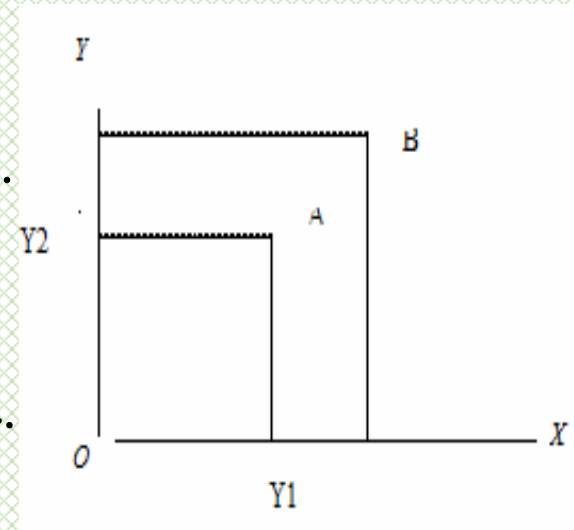
- ❖ Production Possibility Curve represents all possible combinations of two products ( $Y_1$  and  $Y_2$ ) that could be produced with given amounts of inputs.
- ❖ Production Possibility Curve is known as Opportunity Curve because it represents all production possibilities or opportunities available with limited resources.
- ❖ It is called Iso-resource Curve or Iso factor curve because each output combination on this curve has the same resource requirement.
- ❖ It is also called Transformation curve as it indicates the rate of transformation of one product into another.
- ❖ It is also frontier because the limited resource can not help to produce anything beyond Production Possibility Curve.
- ❖ It is concave to origin.
- ❖ The slope of PPC indicate the Marginal Rate of product Substitution.
- ❖ If change in input level, shift the PPC.



# Types of Product-Product Relationships (Enterprise Relationship)

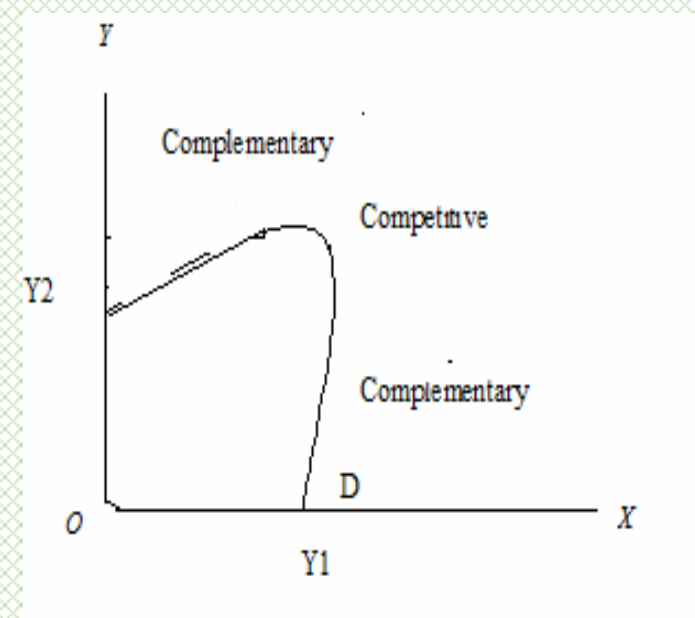
## 1. Joint Products

- The joint product are produced through single production process.
- The two are combined products and Production of one (main product) without the other (by-product) is not possible.
- All agriculture almost all product are joint product.
- In joint product, Marginal Rate of Product Substitution (MRPS) is positive.
- The joint product curve is inverse L-shaped.
- PPC for joint product can be seen as a point for given quantity of resource.
- Example: Paddy & Straw, Meat & Wool etc.



## 2. Complementary Product

- Complementarity between two enterprises exists when with a change in the level of production of one, the other also changes in the same direction.
- That is when increase in output of one product, with resources held constant, also results in an increase in the output of the other product.
- The two enterprises do not compete for resources but contribute to the mutual production by providing an element of production required by each other.
- Complementary product not produced through same direction.
- Production of one is possible without the other but the presence of one has positive effect on other.
- In Complementary Product the marginal rate of product substitution is positive ( $> 0$ ).
- Example: Cereals and pulses, crops and livestock enterprises.
- Maize is grown after berseem crop, the yield of maize crop increase because berseem crop fixes nitrogen and make the soil more fertile for next crop.





# 3. Supplementary Enterprises

- It exists between enterprises when increase or decrease in the output of one product does not affect the production level of the other product.
- Production of one is possible without other.
- They do not compete for resources.
- The marginal rate of product substitution is zero.
- All supplementary relationships should be taken advantage by producing both products up to the point where the products become competitive.

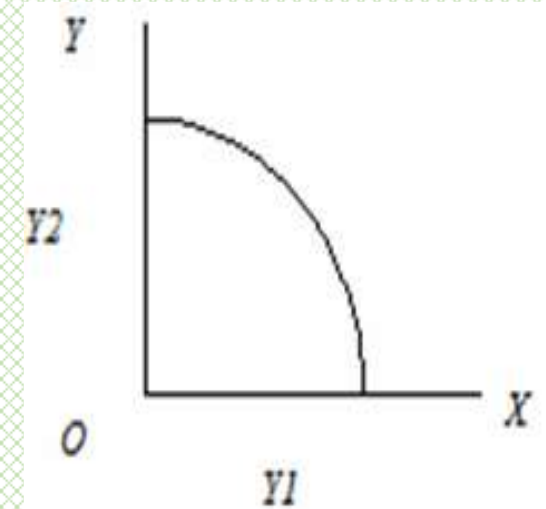
Example:

- small poultry or dairy or piggery enterprise is supplementary on the farm.
- Wheat and maize crop in relation to land.



## 4. Competitive enterprises

- This relationship exists when increase or decrease in the production of one product affect the production of other product inversely.
- That is when increase in output of one product, with resources held constant, results in the decrease of output of other product.
- Competitive enterprises compete for the same resources.
- Two enterprises are competitive in the use of given resources if output of one can be increased only through sacrifice in the production of another.
- MRPS is negative ( $<0$ ).
- Example: Crop and weed, Paddy and Sugarcane etc.



## 5. Antagonistic products

- Two products may be detrimental to each other because of disease or similar factors.
- When this is true, only one of the products should be produced.
- Example: Aqua culture and paddy cultivation.

# Marginal Rate of Product Substitution

- Marginal rate of the product substitution refers to the absolute change in one product associated with a change of one unit in competing product.
- The quantity of one product to be sacrificed so as to gain another product by one unit is called MRPS.

$$MRPS = \frac{\text{Number of units of replaced product}}{\text{Number of units of added product}}$$

$$MRPS_{Y_1 Y_2} = \frac{\Delta Y_2}{\Delta Y_1}$$

$$MRPS_{Y_2 Y_1} = \frac{\Delta Y_1}{\Delta Y_2}$$

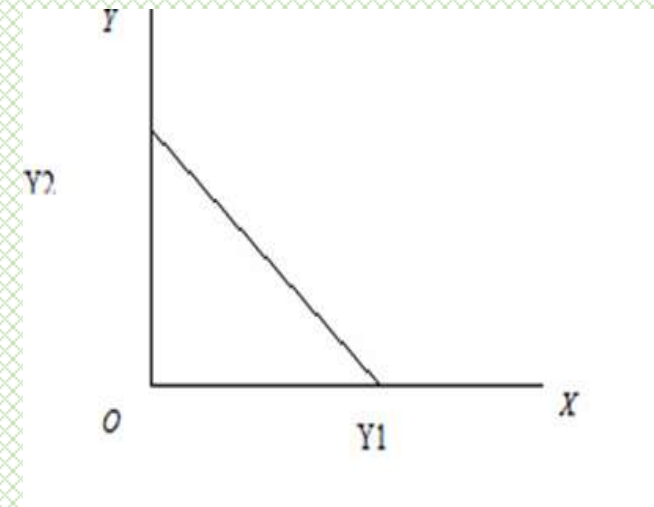
## ❖ Types of Product Substitution

- When two products are competitive, they substitute either at constant rate, or increasing rate or at decreasing rate.

# 1. Constant Rate of Substitution

- It means that unit change in one product is throughout accompanied by the same unit opposite in the other.
- A constant amount of replaced product is sacrificed in order to gain added product by one unit.
- Constant rate of Substitution occurs when One of the production function has an elasticity greater than one (increasing returns), the other has an elasticity of less than one (decreasing returns).
- The PPC is linear when product substitute at constant rate.
- When two products substitute at constant rate, only one of the two products will be economical to produce depending on their relative prices.
- Example; Maize and cotton substitute for land.
- This relationship can be expressed in algebraic form as:

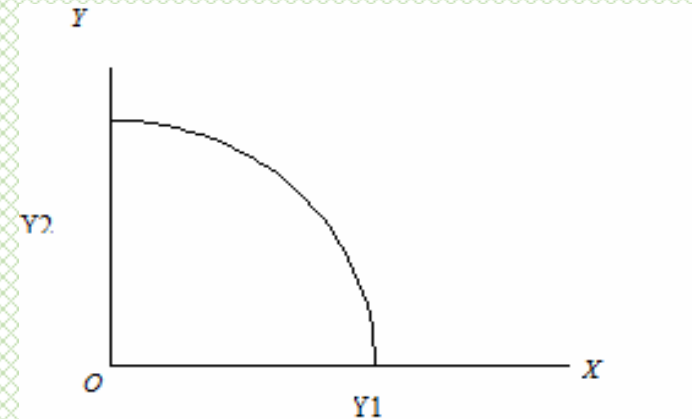
$$\frac{\Delta Y_{11}}{\Delta Y_{21}} = \frac{\Delta Y_{12}}{\Delta Y_{22}} = \dots \dots \dots = \frac{\Delta Y_{1n}}{\Delta Y_{2n}}$$



## 2. Increasing Rate of Product Substitution

- Two product substitute at increasing rate when increase in one product requires larger and larger sacrifice in term of another product.
- Increasing rates of substitution holds true when the production for each independent commodity is one of decreasing resource productivity (decreasing returns) and non-homogeneity in quality of limited resource.
- The PPC is concave to the origin,
- Increasing rate of the product substitution is common in agricultural production.
- The general pattern of production is diversification i.e., profits are maximized by producing both the products.
- Example: All the crop grown in the same season, like Paddy and sugarcane, groundnut and sunflower etc.
- It is expressed in algebraic forms as;

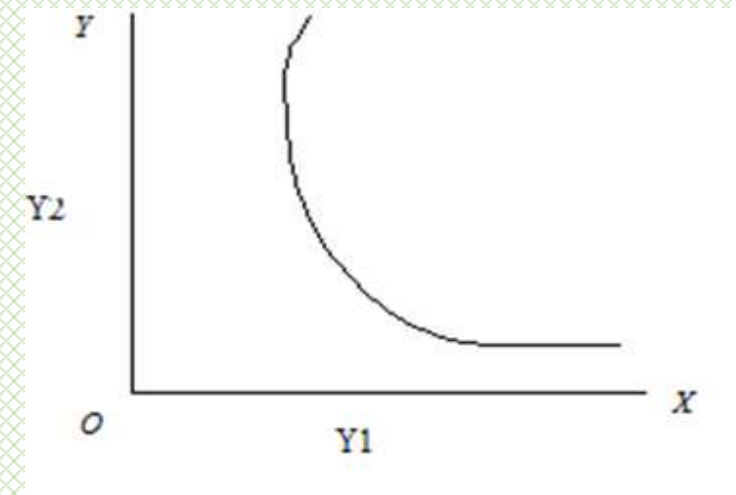
$$\frac{\Delta Y_{11}}{\Delta Y_{21}} < \frac{\Delta Y_{12}}{\Delta Y_{22}} < \dots \dots \dots < \frac{\Delta Y_{1n}}{\Delta Y_{2n}}$$



### 3. Decreasing rate of Product Substitution

- Each unit increase in the output of one product is accompanied lesser and lesser decrease in the production of another product.
- This type of product substitution holds good under conditions of increasing returns.
- PPC is convex to the origin
- It is economical to produce only one of the products depending on the relative prices, when products substitute at constant rate i.e., specialization is the general pattern of production.
- A combination of two product of two product will never give highest return, as such unit increase in one product will require sacrifice of smaller quantity of the other product.
- Such type of relationship are vary rare in agricultural business.
- This relationship is algebraically expressed as:

$$\frac{\Delta Y_{11}}{\Delta Y_{21}} < \frac{\Delta Y_{12}}{\Delta Y_{22}} < \dots \dots \dots < \frac{\Delta Y_{1n}}{\Delta Y_{2n}}$$



# Determination of optimum combination of products

## 1. Algebraic Method:

There are three steps to determine the optimum product combination through algebraic method.

### (a.) Compute Marginal Rate of Product Substitution

$$MRPS = \frac{\text{Number of units of replaced products}}{\text{Number of units of added product}}$$

$$MRPS_{Y_1 Y_2} = \frac{\Delta Y_2}{\Delta Y_1}$$

$$MRPS_{Y_2 Y_1} = \frac{\Delta Y_1}{\Delta Y_2}$$

### (b) Workout price ratio (PR)

$$PR = \frac{\text{Price per unit of added product}}{\text{Price per unit of replaced product}}$$

$$PR = \frac{PY_2}{PY_1} \text{ if it is } MRS_{Y_2 Y_1}$$

$$PR = \frac{PY_1}{PY_2} \text{ if it is } MRS_{Y_1 Y_2}$$

### (c). Optimum combination of enterprises is at where $MRS=PR$

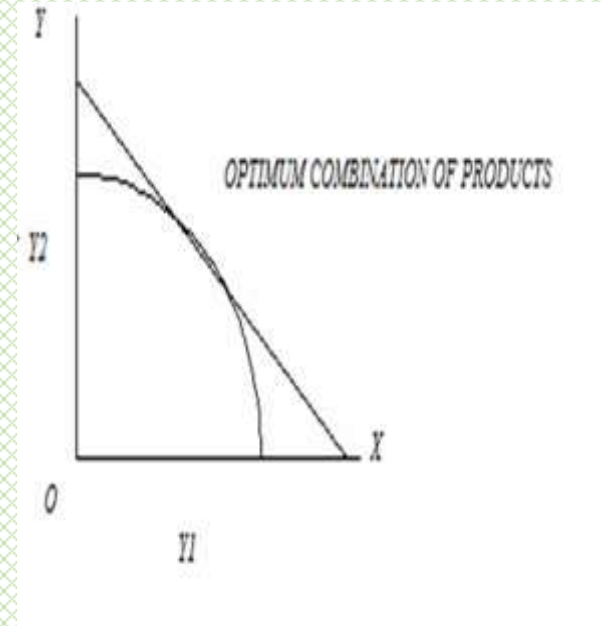
$$\frac{Y_2}{Y_1} = \frac{PY_1}{PY_2} \quad \text{or} \quad \frac{Y_1}{Y_2} = \frac{PY_2}{PY_1}$$

For profit maximization, a rational producer should operate in the range where two products are competitive and within the range, the choice of products should depend upon the MRS and PR.



## 2. Graphic Method

- Draw production possibility curve and iso-revenue line on one graph.
- Slope of production possibility curve indicates MRPS and the slope of iso-revenue line indicates price ratio of products.
- The point of optimum combination of products is at where the iso-revenue line is tangent to the production possibility curve.
- At this point, slope of the iso-revenue line and the slope of the production possibility curve will be the same.
- In other words, the  $MRPS=PR$ .



## 3. Tabular Method

- Compute total revenue for each possible output combination and then select that combination of outputs which yields maximum total revenue. This method is useful only when we have few combinations.
- ❖ **3 units of Y1 and 7 units of Y2 yield maximum revenue**

$Y_1$	$Y_2$	$PY_1 = @Rs. 50$	$PY_2 = @Rs. 80$	Total revenue
8	2	400	160	560
5	3	350	240	490
6	4	300	320	620
4	5	200	400	600
3	7	150	560	710

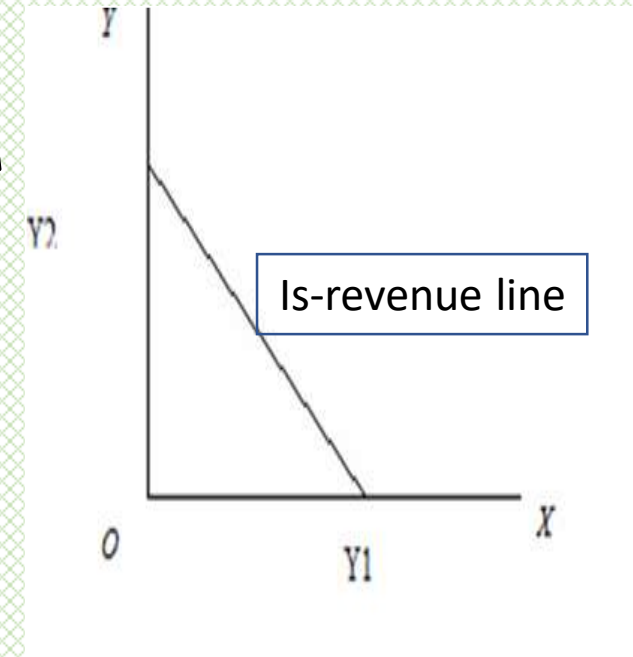


# Iso-Revenue lines

- It represents all possible combination of two products which would yield an equal (same) revenue or income.
- Iso-revenue line is also termed as Iso-return line, Iso-income line, Price line, Equal revenue line.

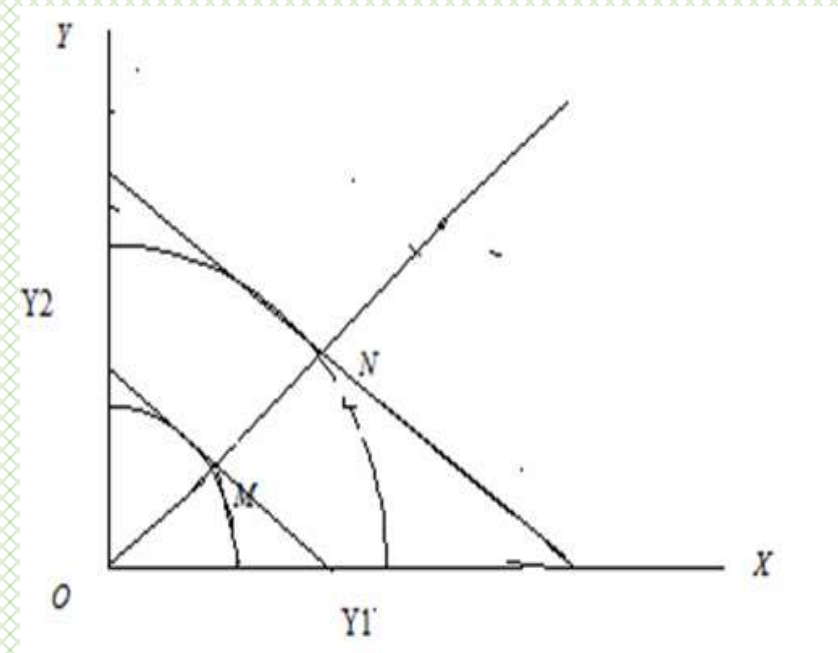
## Characteristics:

- Iso-revenue line is a straight line because product prices do not change with quantity sold.
- As the total revenue increases, the iso-revenue line moves away from the origin.
- The iso-revenue line are parallel to each other, since price ratio remains constant.
- The slope of the iso-revenue line indicates the inverse price ratio of the product.
- The slope is affected by price changes.



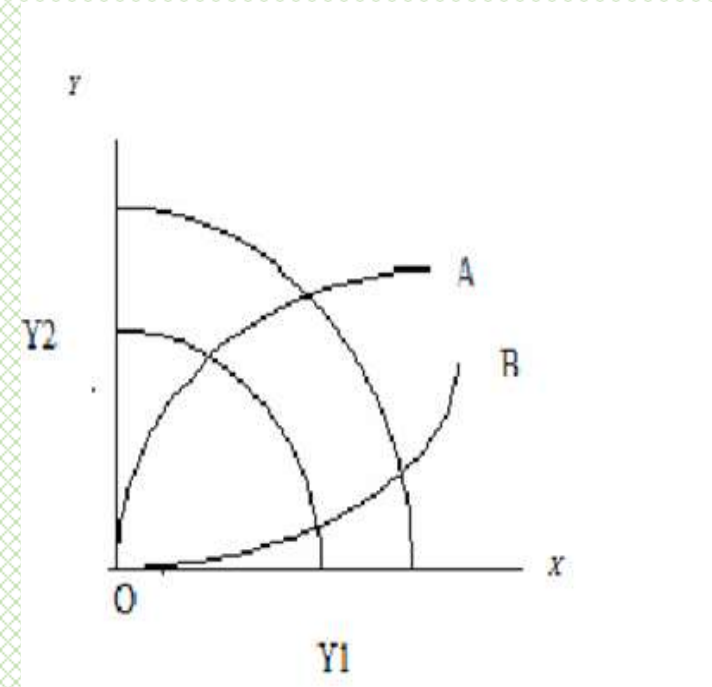
# Expansion path in Product-Product relationship

- Several iso-revenue lines are shown each indicating a different level of revenue.
- Prices are assumed constant and hence the slope of iso-revenue lines remains the same.
- All the iso-revenue lines are tangent to the production possibility curve at different points  $m$ , and  $n$ .
- The line connecting the points of optimum combination of the products is called expansion path.
- The points of tangency specify the most profitable enterprise combination for different possibility curves with the prices indicated by iso-revenue line.



# Ridge lines or border lines

- Line  $OA$  intersects each production possibility curve where the production possibility curve is horizontal. Line  $OB$  intersects each production possibility curve where it is vertical.
- The portions of production possibility curve falling within the ridge lines have negative slope indicating competition ( $MRS < 0$ ).
- Portions of production possibility curve outside ridge line have positive slope indicating Complementarity ( $MRS > 0$ ).
- On the ridge lines  $MRS$  is zero.
- Therefore ridge lines are used to separate ranges of product competition from ranges of product complementarity.





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