Lecture No.10.
  Product - Product relationship - types. Production possibility curve, iso revenue line and optimum combination of outputs

In this section, instead of considering the allocation of inputs to an enterprise or among enterprises, we discuss enterprise combinations or product- mix involving product-product relationships. We deal with what combination of enterprises should be produced from a given level of fixed and variable inputs.

A. PRODUCTION POSSIBILITY CURVE (ISO-RESOURCE CURVE) 200

The production possibility curve or product transformation curve is the locus of maximum amounts of two products, say Y_1 and Y_2, that can be produced from a given quantity of resources ($X^{(0)}$). Mathematically, such product transformation curve is represented by: $Y_1 = f (Y_2, X^{(0)})$ or $Y_2 = f (Y_1, X^{(0)})$. The Rate of Product Transformation (RPT) (or) Marginal Rate Product Substitution (MRPS)

between two products, Y_1 and $Y_2,$ is given by the negative slope of this curve. The RPT of Y_2 for Y_1 can either be expressed as:

dY_1 / dY_2 , the slope of the product transformation curve can be defined as the change (increase or decrease) in the level of Y_1 that must be accompanied by a unit change (decrease or increase) in the product (Y_2) at a given level of resource.

i) Relationship among Products: The basic product relationships can be: joint, complementary, supplementary and competitiveness.

a) **Joint Products:** Products, which result from the same production process, are termed joint products. In the extreme case, two products are combined in fixed proportions and the production of one without the other is impossible. E.g. Grain and straw. Production possibility curves for joint products of this type are presented in Figure 12.1 (a). No substitution is possible in this case. However, for example, different varieties of paddy produce varying proportions of straw and grain. Thus, the proportions may be changed by technologies or cropping practices usually associated with the fixed inputs. For such products, a narrow range of product substitution may exist as presented in Figure12.1 (b).

b) **Competitive Products:** Products are termed competitive when the output of one product can be increased only by reducing the output of the other product. Outputs are competitive because they require the same inputs at the same time. E.g. the manager can expand production of one output only by divert inputs-land, labour, capital and management-from one enterprise to another.

Y₁ ... C • ... B • ... A • ... 0 ... Y₂

Fig.12.1 (a)   **Joint Products**   **Fig.12.1 (b)**
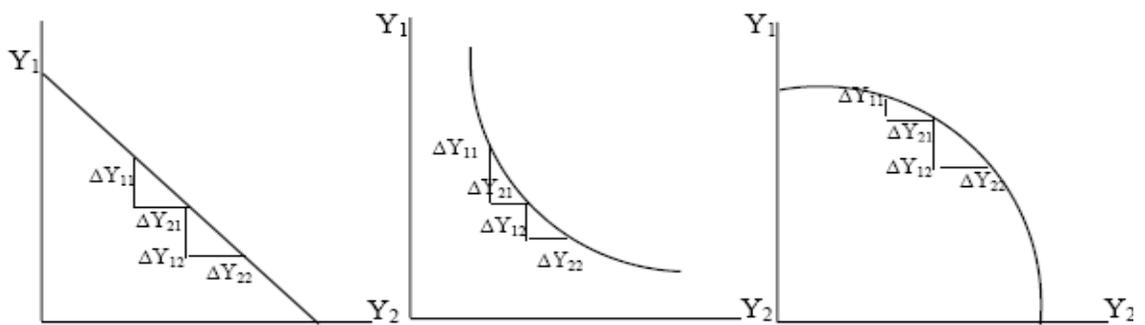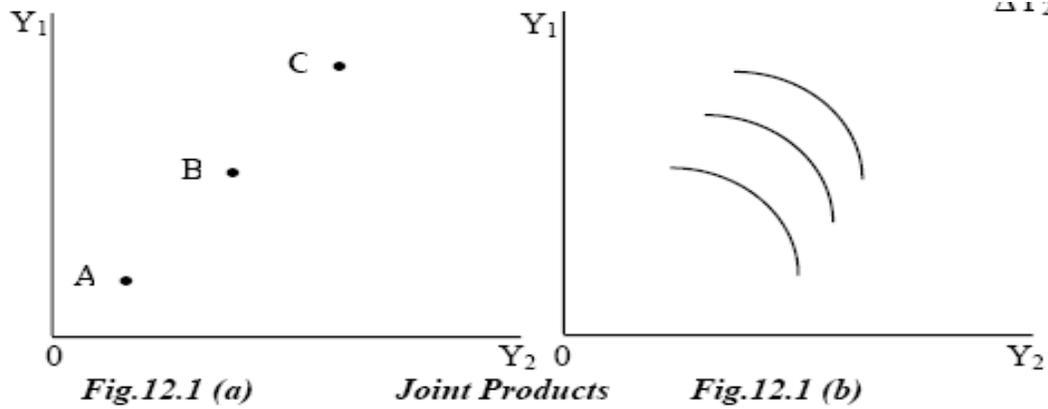
Fig.12.2(a)Constant RPT_{Y2Y1} Fig.12.2(b)Decreasing RPT_{Y2Y1} Fig.12.2(c)Increasing RPT_{Y21}

$$\frac{\Delta Y_{11}}{\Delta Y_{21}} = \frac{\Delta Y_{12}}{\Delta Y_{22}} = \ldots = \frac{\Delta Y_{1n}}{\Delta Y_{2n}} \qquad \frac{\Delta Y_{11}}{\Delta Y_{21}} > \frac{\Delta Y_{12}}{\Delta Y_{22}} > \ldots > \frac{\Delta Y_{1n}}{\Delta Y_{2n}} \qquad \frac{\Delta Y_{11}}{\Delta Y_{21}} < \frac{\Delta Y_{12}}{\Delta Y_{22}} < \ldots < \frac{\Delta Y_{1n}}{\Delta Y_{2n}}$$

When the production possibility curve has a negative slope, the products concerned are competitive. Two competitive products can substitute each other either at a constant or increasing or decreasing rate. Substitution of one product for another product at a constant rate is only a short-run phenomenon because such a relationship may not hold for long. Two varieties of any crop with all inputs held constant, during any single season provide an example of this type of substitution. Economic decision-making is easy in this case, i.e., the farmer would produce only one of these products depending upon yields and prices. Whenever a decreasing RPT exists between two products, every unit addition of one product, say Y_2 replaces less and less of other product, Y_1.The product transformation curve is concave away from origin and convex toward the origin. This type of relationship is quite rare. This type of decreasing RPT can be found in very small farms where capital is very limited and the produce of none of the two competitive commodities can be extended beyond the first stage of production. Decision-making is simple in this case, i.e., the farmer would produce only one of the two products depending on relative yields and prices. An increasing rate of product transformation between two products occurs when both products are produced in the stage of decreasing returns. The product transformation curve is concave towards the origin, i.e., increasing amounts of Y_1 must be sacrificed for each successive gain of one unit of other product, Y_2 for a given level of input.

c) Complementary Products: Two products are complementary, if an increase in one product causes an increase in the second product, when the total amount of inputs used on the two are held constant.

Complementary usually occurs when one of the products produces an input used by the other product. An example of this is the use of a legume in rotation with cash crop. The legume may add nitrogen and improve soil structure or tilth and improve weed and insect control. These factors, in turn, serve as "inputs" for cash crops thus causing, over a period of time required by the rotation, an increase in the production of cash crop. The complementary products may eventually become competitive. For example, while one year of alfalfa in a four-year rotation may be complementary, two, three or four years of alfalfa could be produced only by successive reductions in the cash crops.

$$MRPS = \frac{\Delta Y_1}{\Delta Y_2} > 0.$$

d) Supplementary Products: Two products are called supplementary, if the amount of one can be increased without increasing or decreasing the amount of the other. In figure 12.4 (a) Y_2 is supplementary to Y_1. Y_2 can be increased from zero to OH amount without affecting the amount of Y_1 produced. Beyond E, the two outputs become competitive. In Fig.12.4 (b), each enterprise is supplementary to the other and competitive between FG.

Supplementary enterprises arise through time or when surplus resources are

Between EF, Y_2 is supplementary to Y_1.
Between GH, Y_1 is supplementary to Y_2
Between FG, Y_1 and Y_2 are substitutes
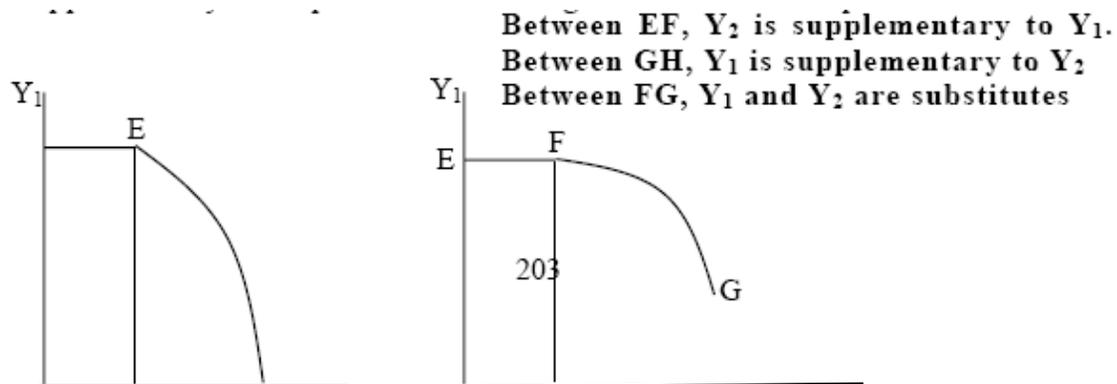
Supplementry Products

available at a given point of time. Once purchased, a tractor is available for use throughout the year. Its use in one month does not prevent its use in another month. Thus, a tractor purchased to plough and plant may be put to a lesser use during the off-season. If two crops were harvested at the same time, however, the relationship would be competitive-use on one could reduce the amount of use on the other.

The supplementary relationship between products depends upon amount of use left in the resource. If the harvester is completely worn out harvesting corn in June, it will not be available

for use in July. Milk cows and family gardens represent supplementary enterprises on some farms. In each case, labour or some other input is available for use on a small scale and rather than let it go idle, a small enterprise is undertaken.

$$\text{MRPS of } Y_2 \text{ for } Y_1 = \frac{\Delta Y_1}{\Delta Y_2} = 0$$

Production possibility curve is also known as opportunity curve as it presents all possible production opportunities.

ii) Marginal Rate of Product Substitution or Rate of Product Transformation: RPT is nothing but the slope of production possibility or opportunity curve.

$$\text{MRPS of } Y_2 \text{ for } Y_1 = \frac{-\Delta Y_1}{\Delta Y_2}$$

The marginal rate of product substitution means the rate of change in quantity of one output (Y_1) as a result of unit increase in the other output (Y_2), given that the amount of the input used remains constant. As the amount of Y_2 produced increases, the amount of Y_1 sacrificed steadily increases. This is due to the decreasing marginal physical products displayed by the production functions.

iii) Iso Revenue Line: It is the line which defines all possible combinations of two commodities which would yield an equal revenue or income. Iso revenue line indicates the ratio of prices for two competing products. The point on Y_2 axis is always equal to TR/PY_2 while the point on the Y_1 axis equal TR/PY_1. The distance of the Iso revenue line from the origin is determined by the magnitude of the total revenue. As total revenue increases, the iso revenue line moves away from the origin. The slope of the iso revenue line is determined by the output prices.
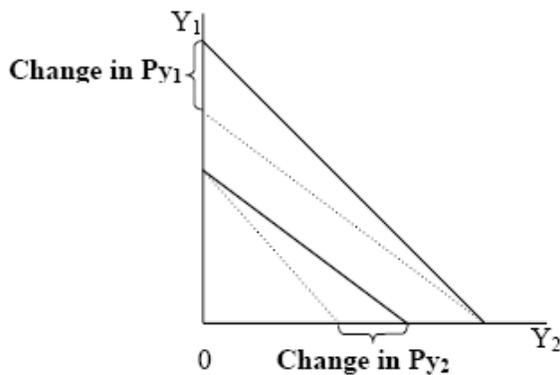
Fig.12.5 Iso Revenue Line

Thus, the output prices ratio is the slope of the iso revenue line. The negative sign means that the iso revenue line slopes downward to the right. The iso revenue lines are used for revenue optimization, while iso cost lines are used for cost minimization.

iv) Revenue Maximizing Combination of Outputs

The maximum revenue combination of outputs on the production possibility

$$\text{MRPS of } Y_2 \text{ for } Y_1 = \frac{\Delta Y_1}{\Delta Y_2} = -\frac{Py_2}{Py_1}$$
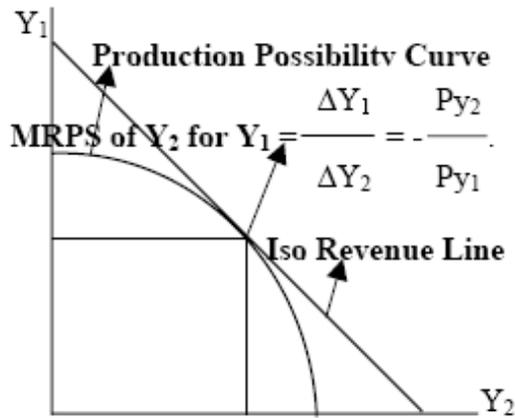
Fig.12.6 Maximum Revenue Yielding Combination

This can be rewritten as follows:

$Py_1(\Delta Y_1) = - Py_2(\Delta Y_2)$. This criterionstates that at the maximum revenue point,the increase in revenue due to adding aminute quantity of Y_2 is exactly equal tothe decrease in revenue caused by thereduction in Y_1. Thus, there is no incentiveto change the output combination. When $Py_1 (\Delta Y_1) > - Py_2 (\Delta Y_2)$, the amount of Y_2 should be decreased in favour of Y_1. When $Py_1 (\Delta Y_1) < - Py_2 (\Delta Y_2)$, then Y_2 should be increased at the expense of Y_1. As could be seen in the Figure 12.7, the line connecting maximum revenue points is called output expansion path. For each level of input, the maximum revenue combination of outputs will fall on the expansion path.