Lecture No.4.

Factor - Product relationship - Production function - definition & types - linear, quadratic & Cobb- Douglas functions - Impact of technology.

Factor – Product Relationship (Or) Input – Output Relationship

The objective of factor-product relationship is to determine the optimum quantity of the variable input that will be used in combination with fixed inputs in order to produce optimal level of output. Further questions such as, how much fertilizer to be applied per acre? how much irrigation to be given? and so on are all within the scope of factor – product relationship. There can be three types of input-output relationships in producing a commodity where one input is varied and the quantities of other inputs are fixed. The nature of relationships between a single input and a single output can either be of the one or a combination of types given below:

i) Constant Marginal Rate of Returns or Law of Constant Returns.

ii) Increasing Marginal Rate of Returns or Law of Increasing Returns.

iii) Decreasing Marginal Rate of Returns or Law of Decreasing Returns.

A. LAWS OF RETURNS

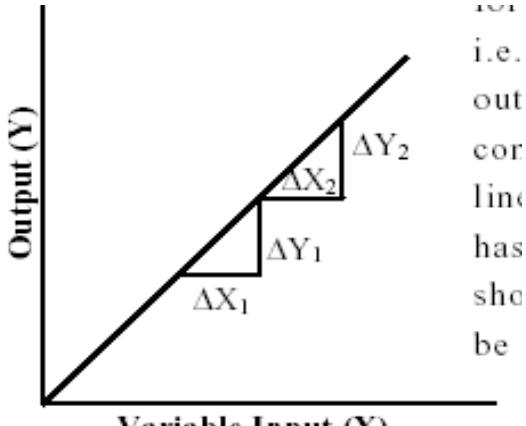


Fig. 10.1.Law of Constant Returns

Let us consider the simplest case where one product is produced by varying the level of only one factor of production at a time.

Law of Constant Returns: The level of output increases by an equal amount for each additional units of the variable input i.e., the relationship between the input and the output is linear. Thus, graphically, the law of the law of constant returns can be depicted by a straight-line production function. The production functionhas the same slope throughout its entire range asshown in the figure 10.1. Mathematically, it canbe

$$\frac{\Delta Y_1}{\Delta X_1} = \frac{\Delta Y_2}{\Delta X_2} = \ldots = \frac{\Delta Y_i}{\Delta Xi} = \ldots = \frac{\Delta Yn}{\Delta Xn} = k$$

Where ΔYi /ΔXi is the marginal product due to the use of the i^{th} unit of variable input, X (i = 1, 2,…,n) and k is a constant. Such constant returns can occur under two situations:

a) No resource is fixed and all the inputs are varied, increased or decreased together.

b) One or more factors of production may be fixed but they have surplus (unutilized) capacity. The constant returns may be explained with the data given

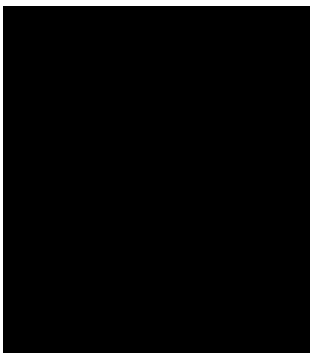
Table 10.1 Yield of Maize at Varying Levels of Nitrogen per Hectare

Variable Inputs (Kg of N per ha)	ΔXi	Output (quintals of Maize per ha)	ΔYi	$MPP = \frac{\Delta Yi}{\Delta Xi}$
0	-	25	-	-
25	25	26	1	0.04
50	25	27	1	0.04
75	25	28	1	0.04
100	25	29	1	0.04

:The table (10.1) shows that every addition of 25 Kg of nitrogen ΔXi causes exactly the same increase of one quintal in the yield of maize per ha (ΔYi) during the process of production.

stated as under:

ii)



Variable Input(X)

Fig.10.2 Law of Increasing Returns

Law of Increasing Returns: Increasing returns are said to operate when every successive unit of the variable input results in a larger increase in the output as compared

At lower level of fertilizer

increase when fertilizer application is increased upto a certain level. The following table illustrates the law of increasing returns with the help of data on

to the preceding unit. Such an input-output relationship is generally encountered at a relatively lower level of input use. The resulting production function is a non-linear curve of the type shown in the figure 10.2 and is convex to the input axis. Mathematically, the law can be

$$\frac{\Delta Y_1}{\Delta X_1} < \frac{\Delta Y_2}{\Delta X_2} < \ldots < \frac{\Delta Y_i}{\Delta Xi} < \ldots < \frac{\Delta Yn}{\Delta Xn}$$

where, AY_i/Xi, .i = 1, 2, 3, . . . , n is the marginal product due to the use of .i th unit of

the variable input (X). Thus, in terms of marginal productivity of the variable factor of production, the law of increasing return signifies an increasing marginal product with n addition of every successive unit of the variable resource

paddy yield at varying levels of nitrogen application. The example given in the table (10.2) indicates the response of paddy yield to increasing nitrogen application at a very low level of the input-use. It may be observed that as the input is increased from 0 to 25 kgs per hectare, a dose of 5 kg at each step, the

Table 10.2 Yield of Paddy at Varying Levels of Nitrogen per Hectare

Variable Input (Kg of nitrogen per Ha)	AXi	Output (Quintals of paddy per Ha)	A Y ;	MPP = AYi / AXi
0	-	20.0	-	-
5	5	21.0	1.00	0.20
10	5	22.5	1.50	0.30
15	5	24.5	2.00	0.40
20	5	27.0	2.50	0.50
25	5	29.7	2.70	0.54

yield increases by 1.0, 1.5, 2.0, 2.5 and 2.7 quintals per hectare. Thus, every successive dose of 5 Kgs of nitrogen results in more output of paddy signifying the operation of the law of increasing returns.

iii) Law of Diminishing Marginal Returns: When one variable input used for the production of a certain commodity is increased relative to other inputs, the physical output obtained from each added unit of the variable input(s), tends to decline after a certain point has been reached. Thus, each additional unit of the variable input results in less and less addition to the total output as shown in the figure 10.3. Mathematically,

AY1A Y2 A Yi AYn

X1A X2 AXi AXn

Variable Input (X)

Fig. 10.3 Law of Decreasing Returns

where AY i / AXi , i =1, 2, 3, . . . n is the marginal product due to the use of ith unit of the variable input (X). Thus, the marginal productivity of the variable input X goes on declining with the increasing level of total output as a result of more intensified use of the variable factor. This type of return can be shown geometrically by a non-linear curve of the type shown in the figure 10.3. Such a curve would be concave to the input axis and convex upwards.

We can also demonstrate the operation of this law with the help of data on nitrogen application and yield of paddy per hectare in

The table 10.3 would reveal that as more of the variable input (X) is used, the yield of paddy also keeps on increasing till 90 kgs of nitrogen application and results in 69 quintals of paddy yield per ha. However, the paddy yield remains unchanged when the variable input level is increased from 90 to 120 Kg per hectare. Further, it could be noted that every addition of one kg of nitrogen nutrient (AXi) adds less and less of output, i.e., from 0.60 to 0.33, from 0.33 to 0.13 and so on. This is a technological law of biological responses and is

Table 10.3 Yield of Paddy at Varying Levels of Nitrogen per Hectare

Variable Input (Kgs of Nitrogen per Ha)	AXi	Output (Quintals of Paddy per Ha)	AYi	A Yi / MPP = A Xi
0	-	37	-	-
30	30	55	18	0.60
60	30	65	10	0.33
90	30	69	4	0.13
120	30	69	0	0

applicable in almost all-practical situations of agricultural production under varied farm situations. This law also refers to diminishing marginal productivity of a variable factor of production, with other factors held constant at some specified levels, as its use is intensified.