Lecture No. 5

Law of diminishing returns - 3 regions of production

a) Law of Diminishing Marginal Returns (LDMR)

Alfred Marshall stated the law thus: “An increase in labour and capital applied in the cultivation of a land causes, in general, a less than proportionate increase in the amount of produce raised, unless it happens to coincide with an improvement in the arts of agriculture”.

The advancement in agricultural technology may bring about changes where the operation of this law is delayed, for example, by evolving, varieties of crops, which give higher yields at higher levels of fertilizer application. But so far, science has not succeeded in stopping the operation of this law in agriculture. The law of diminishing returns is also called the law of variable proportions. E.O. Heady has stated that if the quantity of one productive service is increased by equal increments, with the quantity of other resource services held constant, the increment to total product may increase at first but will decrease, after a certain point. In other words, as the amount of a variable resource used in the production of an output is increased, the level of output will at first increase at an increasing rate, then increase at a decreasing rate and finally a point will be

reached, where further applications of the variable resource will result in a decline in the total output of the production.

b) Relationship between Total, Average and Marginal products (or) Three Stages or Phases or Zones of Production Function: Since both average and marginal products are derived from total product, the average and marginal product curves are closely related to the total product curve. The input-output relationship showing total, average and marginal productivity can be divided into three regions in such a manner, that one can locate the portion of the production function, in which the production decisions are rational. A non-linear total product curve and the three zones of production are shown in the figure 10.4.

Stage I: As we increase the level of a variable input, say seed rate per hectare, the total production (yield per hectare) increases at an increasing rate till point 'L' is reached on the TPP curve. Thus, upto this point (L) the marginal physical product (MPP) is shown as increasing and then it starts declining. Point L is the point of inflection on the TPP curve where the curvature changes from convex to concave to the input axis as we move away from origin. The TPP curve is continuously increasing but at a decreasing rate as we move from the point L to M on TPP by increasing the seed rate from Xi to Xm. The stage I ends at the point N where marginal product is equal to average product when the latter is at its maximum. In this stage, APP keeps on increasing and MPP remains greater than APP. It is not reasonable to stop the use of an input when it's efficiency-in use is increasing (This is indicated by continuous increase in APP). In this stage, more use of variable input increases its physical production efficiency in combination with fixed inputs. So it is irrational to stop increasing the use of variable input, as long as fixed inputs are not fully utilized. For this reason, it is called irrational stage of production.

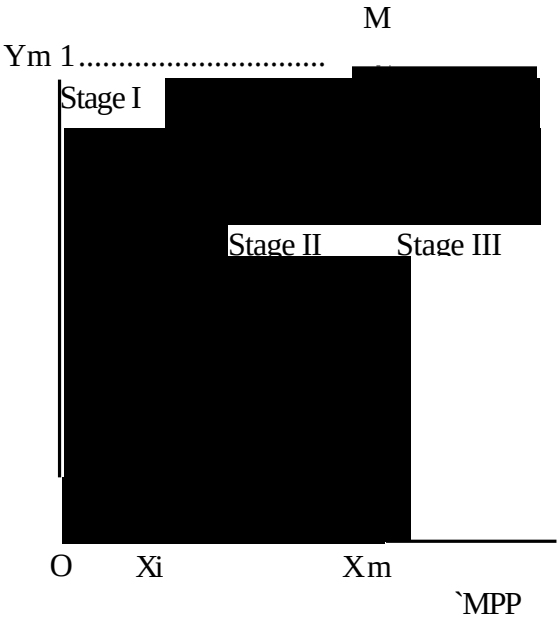

Fig 10.4 Three Zones

Stage II: The Stage II occurs when MPP is decreasing and is less than APP. In Stage II, MPP is equal to or less than APP but equal to or greater than zero. It

starts at a point where APP is at its maximum and ends where the total product is at its maximum. Within the boundaries of this region is the area of economic relevance. It is only in this region that marginal product of variable and fixed factors are positive. Optimum point of input-use must be somewhere in this region. Hence, it is called rational stage of production. The optimum point can, however, be located only when input and output prices are known. It needs to be emphasized that this region of rational production embodies diminishing returns phase. Both average and marginal products are decreasing in this region.

Stage III: A part of TPP curve beyond the point M is called the third phase of production. As variable input use is extended beyond X_m, the marginal product beyond point M is negative. It is irrational to increase the input level for obtaining lower total product. Thus, Stage III is also called irrational stage of production. The difference between the irrationality in Stage I and Stage III can be explained in terms of scarcity of the variable input in Stage I and its excess use in Stage III in relation to the fixed factors of production. Thus, while the marginal product of the variable factor is negative in the third stage of production, the same is precisely true for the fixed factor in the first stage of production. E.g.) more fertilizer dosage, excessive irrigation, etc. would result in reduction of yield.

Total physical product function (TPP): $Y = 4X+2X^2- 0.1X^3$

Average physical product function (APP): $Y /X = 4+2X-0.1X^2$
Marginal physical product function (MPP): $= dY / dX = 4 + 4X - 0.3X^2$ c)

Relationship between APP, MPP and Elasticity of Production

The elasticity of production refers to the percentage change in output in response to the percentage change in input. It can be denoted by Ep and can be computed as:

computed as: $$Ep = \frac{\left[\frac{\Delta Y}{Y} \times 100\right]}{\left[\frac{\Delta X}{X} \times 100\right]} = \frac{\left[\frac{\Delta Y}{Y}\right]}{\left[\frac{\Delta X}{X}\right]} = \frac{\Delta Y}{\Delta X} \times \frac{X}{Y}.$$ Therefore, $$Ep = \frac{\Delta Y}{\Delta X} \times \frac{1}{Y/X} = \frac{MPP}{APP}$$

Thus, elasticity of production can also be worked out if MPP and APP are known. In the figure 10.4, at the end of stage I, the Ep is unity (a one per cent increase in input is always accompanied by a one per cent increase in output). In stage I, MPP is greater than APP. Therefore, Ep is greater than 1. In stage II, MPP is lesser than APP and Ep is lesser than one, but greater than zero,

(0 <_ Ep <_ 1). In stage III, MPP is negative and Ep is also negative. E.g. when X increases from 0 to 1 unit and Y increases from 0 to 5,

$$Ep = \frac{5\ (0 + 1)}{1\ (0 + 5)} = 1.00$$

When X increases from 1 to 2 units and Y increases from 5 to 11 (Arc elasticity method),

$$Ep = \frac{6\ (1 + 2)}{1\ (5 + 11)} = \frac{18}{16} = 1.125.$$

d) Impact of Technological Change on Production Function: Technology is the knowledge applied by man to improve production or marketing process. The physical and value productivities of farm resources have been changing continuously due to the constant flow of innovations in agriculture. Technology can help producing more quantity of product per unit of input. This means that more total output can be produced from inputs that were used prior to the technological innovation, or the same amount of total product can be produced with fewer resources. There can be different levels and grades of technology available to a farmer. For example, application of fertilizer is possible with the broadcast method, band application and or spray method. Use of same quantity of the fertilizer through different methods (technologies) will give different yield levels. Similarly a different variety of a crop (paddy) such as white *ponni*, IR20, IR 50, etc will give different yields. For the same quantity of input, different yield levels can be obtained (Y_1, Y_2 and Y_3) using different types of technologies (T T and T) as shown in Fig.10.5. The technological advances result in:

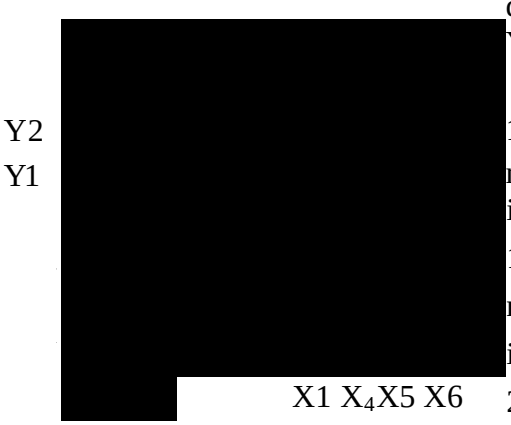

Fig.10.5 Impact of Technological Change on Production Function

1) Factor saving technologies, or cost reducing technologies, such as development of improved tractors.

2) Yield increasing technology – high yielding varieties and hybrid varieties.

3) Both factor saving and yield increasing technology.