

## AGROFORESTRY OPTION TO INCREASE FOREST PRODUCTION

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### Abstract

Wood, especially fuelwood is a resource of great concern in developing countries. There is a high dependence on fuelwood for domestic energy in Pakistan and majority of people, especially in rural areas depends upon it. Pakistan's population has expanded with one of the highest rates of growth in the world, while the forest production for the last many years remained almost constant. Wood production can be increased either by increasing the area under forest or by introducing agroforestry on farmlands and improving the productivity of agroforestry practices. This paper highlights the possibility of increasing forest production along with agriculture production about 40% per unit area.

Pakistan has very small forest resource, as forests cover about 5% of its total area. This compares with averages in Asian countries of 21%, Africa of 23%, North America of 32% and South America of 53% (McKetta, 1990). Agroforestry is the biggest option among the foresters to green the country and accelerate wood production. The scenario is not so simple as is being advocated. Traditionally, farmers are sensitive to produce forest at the cost of agriculture. It is quite difficult to make them understand that food and wood are parallel needs. A forester or researcher to avoid any serious consequences should be fair in implementing his ideas. The package given to the farming community should be independent and base on sound economic principles.

Before improving the production of an enterprise, one should be clear about the optimum production, i.e., the production where profit is maximized. Therefore, the goal of maximum yield from a fixed input such as land is not compatible with the goal of maximum profit per unit of fixed input as long as there is a price tag attached to the variable input such as fertilizer.

### Steps in agroforestry production

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### Average production

The production function portrays an input-output relationship. It describes the rate at which resources are transformed into products. There are numerous input-output relationships in agriculture because the rates at which inputs are transformed into outputs vary among soil types, animals, technologies, rainfall amounts, and so forth. Any given input-output relationship specifies the quantities and qualities of resources needed to produce a particular product. Symbolically, a production function can be written as

$$Y = f(X_1, X_2, X_3, \dots, X_n)$$

where  $Y$  is output and  $X_1, \dots, X_n$  are different inputs that take part in the production of  $Y$ . The functional symbol 'f' signifies the form of the relationship that transforms inputs into output. For each combination of inputs, there will be a unique amount of output. The above symbolic relationship simply lists the inputs. In its present abstract form, it does not specify their importance or their contribution to the production process.

There are various forms of production functions that can be used in deriving input-output relations and determining average production. No single form can be used to characterize production under all environmental conditions. Common forms include Cobb-Douglas, Quadratic, Square Root, 1.5 Polynomial, etc.

### Frontier production

Farrel (1957) assumed that observed input per unit of output values for firms would be above the so-called unit isoquant. The unit isoquant defines the input per unit output ratios associated with the most efficient use of inputs to produce the output involved. The deviation of observed input per unit output ratios from the unit isoquant was considered to be associated with technical efficiency. On the other hand, technical inefficiency is defined as firm's failure to produce maximum output from a given set of inputs.

## Optimum production

The measure of 'economic efficiency' is divided into two components namely, technical (production) efficiency and allocative (price) efficiency. Technical efficiency, by definition, is the ratio of the farmer's actual output and the output derived from frontier function (maximum possible) with the existing level of input use. Allocative efficiency is the ratio of the frontier output computed with the existing average level of inputs and the output obtained from frontier function with the optimum level of input use. And economic efficiency or more precisely economic potential may be arrived at by dividing the existing average output by the optimum output estimated with the help of frontier function using the optimal input level. To determine the optimum use of inputs, the partial derivative of the frontier function with respect to each factor is equated to the respective factor-product market price ratio while keeping the other factors at mean level.

## Maximum revenue combination

The relationships among products on the farm may take different forms depending on the particular situation. In general, products can be competitive, complementary, or supplementary.

The production possibility frontier is a convenient device for depicting two production functions on one graph. Suppose that one input,  $X$ , can be used to produce two products,  $Y_1$  and  $Y_2$ , and that all other inputs used to produce  $Y_1$  or  $Y_2$  are fixed. Production possibility frontier is also called isoresource curve because each point on the frontier represents combination of outputs produced using equal (iso) amount of inputs.

Thus, the combinations of outputs that fall on the production possibility frontier represent the maximum amounts of outputs that can be attained given the manager's resource situation. The mathematical representation of production of two products from a non-allocable factor is the two production functions,

$$Y_1 = f_1(x)$$

$$Y_2 = f_2(x)$$

Suppose that  $K$  units of input  $X$  were available. Production functions

represent planning curves and before any input is actually used, the manager has the opportunity to consider all possible ways the input can be used the manager has the opportunity to consider all possible ways the input can be used. By using all K units of input on  $Y_1$ , he can produce M units of  $Y_1$ , or if all K units are used in  $Y_2$ , N units of  $Y_2$  can be produced. Many other combinations are possible within these two extremes.

A product-product relationship for example  $Y_1$  and  $Y_2$  could be described by the following equation:

$$Y_1 = a - bY_2^2$$

### Marginal rate of production substitution

The marginal rate of product substitution is defined as the slope of the production possibility frontier or opportunity curve. Thus,

$$\text{MRPS of } Y_1 \text{ for } Y_2 = \frac{dY_1}{dY_2}$$

Supposing the output combinations  $Y_2 = 40$ ,  $Y_1 = 20$  and  $Y_2 = 30$ ,  $Y_1 = 25$ , on the given production possibility frontier. The MRPS of  $Y_1$  for  $Y_2$  between these combinations is,

$$\frac{\Delta Y_2}{\Delta Y_1} = \frac{30 - 40}{25 - 20} = \frac{-10}{5} = -2$$

This is the average or approximate measure of the MRPS between two points. The exact MRPS is the slope at any point on the production possibility frontier and can be determined by drawing a tangent at the point in question and then measuring the slope of the tangent. Whenever the MRPS or the slope of the production possibility frontier is negative, the relationship among products is competitive, i.e., an increase in one product necessitates a decrease in another product. When MRPS or the slope of the production possibility frontier is positive, the relationship among products is complementary, i.e., an increase in one product brings about an increase in the other product. And when MRPS is zero or undefined, the relationship among products is supplementary, i.e., an

increase in one product brings about an increase in the other product.

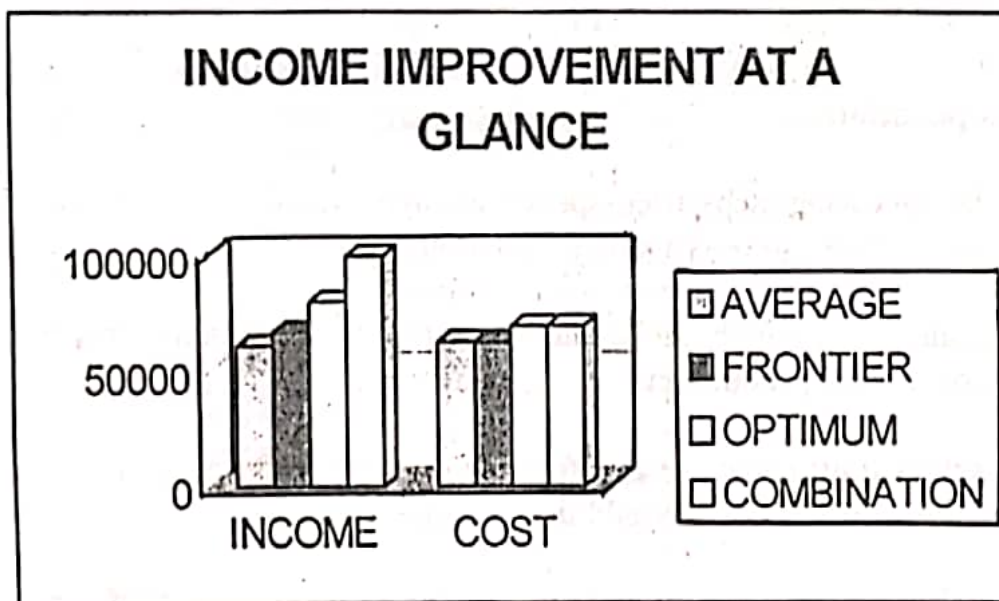
**Isorevenue line**

Total revenue is the value of outputs produced,

$$\text{Total Revenue (TR)} = P_{Y1} Y_1 + P_{Y2} Y_2$$

where  $Y_1$  and  $Y_2$  represent the total amounts of the two products while  $P_{Y1}$  and  $P_{Y2}$  are the prices per unit of these products. The location of an isorevenue line for any total revenue can easily be determined by computing the points on the axes and connecting these points with a straight line. The point on the  $Y_2$  axis is always equal to  $TR/P_{Y2}$  while the point on the  $Y_1$  axis is always equal to  $TR/P_{Y1}$ . These points determine the amount of either  $Y_2$  or  $Y_1$  needed to earn the total revenue when the other product is not produced.

|            | <i>AVERAGE</i> | <i>FRONTIER</i> | <i>OPTIMUM</i> | <i>COMBINATION</i> |
|------------|----------------|-----------------|----------------|--------------------|
| IMCOME (%) | 100            | 109             | 124            | 139                |
| COST (%)   | 100            | 100             | 110            | 110                |



(Source: Afzal, 1998)

Fig.1: Showing income improvement at different stages of production

The slope of the isorevenue line is determined by the output prices. The slope of a straight line may be measured between any two distinct points. For convenience, the slope can be measured between the points where the isorevenue line intersects the output axes. The  $Y_2$  axis is intersected at the point  $Y_1 = 0$  and  $Y_2 = TR/P_{Y_2}$  while the  $Y_1$  axis is intersected at the point  $Y_2 = 0$  and  $Y_1 = TR/P_{Y_1}$ . The slope of the isorevenue line is,

$$\begin{aligned} \text{Slope of Isorevenue Line (SIL)} &= \frac{\text{Rise}}{\text{Run}} \\ &= (0 - \frac{TR}{P_{Y_2}}) / (\frac{TR}{P_{Y_1}} - 0) = (-\frac{TR}{P_{Y_2}}) / (\frac{TR}{P_{Y_1}}) = -\frac{P_{Y_1}}{P_{Y_2}} \end{aligned}$$

Thus, the output price ratio is the slope of the line. The negative sign, of course, means that the isorevenue line slopes downward to the right. The combination of  $Y_1$  and  $Y_2$  that maximizes revenue will lie on the production possibility frontier where,

$$\frac{\Delta Y_2}{\Delta Y_1} = -\frac{P_{Y_1}}{P_{Y_2}}$$

### Policy implications

The following steps need special attention for effective improvement in agricultural crops as well as wood production.

1. A survey should be conducted to establish input-output relationship in agroforestry production.
2. Technical efficiency of agroforestry should be improved, i.e., increasing production without any additional cost.
3. Optimum resource utilization to fetch maximum profit should be determined, i.e., withdrawing over-utilization or putting forth more resources if there exists no resource constraint.

4. Nature of relationship among different tree species and agricultural crops should be detected.
5. Based on the relationship among tree species and agricultural crops, maximum revenue combination of both the products at existing and optimum input use should be determined.

### References

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