

**Study Material**  
**Course No.: Ag Econ 122**  
**(Production Economics and Farm Management)**  
**Credit Hours : 1 + 1=2; Semester:II**

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### **Course Contents (Theory)**

- Production Economics: Meaning, definition.
- Nature and scope of Agricultural Production Economics.
- Basic concepts and terms.
- Meaning and types of production functions
- Laws of returns: Increasing, constant and decreasing.
- Factor-product relationship. Determination of optimum input and output.
- Factor-factor relationship.
- Product-product relationship.
- Type of enterprise relationship.
- Returns to scale: meaning, definition, importance.
- Farm management definition, scope, importance.
- Typical farm management decisions.
- Economic principles applied to the organization of farm business.
- Types and systems of farming,
- Cost concepts and farm efficiency.
- Farm planning and budgeting.
- Risk and uncertainty.
- Linear programming: Assumption, advantages and limitations of linear programming.

### **Course Outline (Practical)**

- Application of Farm Management Principles
- Computation of cost concepts
- Methods of consumption of depreciation
- Analyses of net worth statement
- Farm inventory analysis
- Preparation of farm plans and budgets
- Types of farm records and account
- Preparation of profit and loss account
- Break even analysis
- Cost of cultivation and economic analysis of different crop and livestock enterprises.

### **Examination Schedule & Distribution of Marks:**

1.	Mid Term Practical (Internal)	15%
2	End Term Practical (Internal)	35%
3	End Term Theory (External)	50%
	<b>Total Marks</b>	<b>100</b>

### **References**

1. Johl, S.S. and Kapoor, T.R. (1973), Fundamentals of Farm Business Management, Kalyani Publishers, Ludhiana.
2. Sankhayan, P.L. (1988), Introduction to the Economics of Agricultural Production, Prentice Hall of India Private Limited, New Delhi-110 001.
3. Raju, V.T. and Rao, D.V.S. (1990), Economics of Farm Production and Management, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi-110 001.
4. Dhondyal, S.P. (1985), Farm Management, Friends Publication Meerut (India).
5. Kahlon, A.S. and Karam Singh (1992), Economics of Farm Management, Allied Publishers, New Delhi.
6. Doll, John P. and Orazem. F. (1984), Production Economics: Theory with Application, John Wiley and Sons, New York.

## **Lecture 1**

### **Production Economics-Meaning & Definition, Nature and Scope of Agricultural Production Economics**

#### **Agricultural Economics**

As a separate discipline, agricultural economics started only in the beginning of 20<sup>th</sup> century when economic issues pertaining to agriculture aroused interest at several educational centres. The depression of 1890s that wrecked havoc in agriculture at many places forced organized farmers groups to take keen interest in farm management problems. The study and teaching of agricultural economics was started at Harvard University (USA) in 1903 by Professor Thomas Nixon Carver. Agricultural economics may be defined as the application of principles and methods of economics to study the problems of agriculture to get maximum output and profits from the use of resources that are limited for the well being of the society in general and farming industry in particular.

#### **Nature and Scope of Agricultural Economics**

Agriculture sector has undergone a sea change over time from being subsistence in nature in early stages to the present day online high-tech agribusiness. It is no more confined to production at the farm level. The storage, processing and distribution of agricultural products involve an array of agribusiness industries. Initially, agricultural economics studied the cost and returns for farm enterprises and emphasized the study of management problems on farms. But now it encompasses a host of activities related to farm management, agricultural marketing, agricultural finance and accounting, agricultural trade and laws, contract farming, etc.

Both microeconomics and macroeconomics have applications in agriculture. The production problems on individual farms are important. But agriculture is not independent of other sectors of the economy. The logic of economics is at the core of agricultural economics but it is not the whole of agricultural economics. To effectively apply economic principles to agriculture, the economist must understand the biological nature of agricultural production. Thus, agricultural economics involves the unique blend

of abstract logic of economics with the practical management problems of modern day agriculture.

The widely accepted goal of agricultural economics is to increase efficiency in agriculture. This means to produce the needed food, fodder, fuel and fibre without wasting resources. To meet this goal, the required output must be produced with the smallest amount of scarce resources, or maximum possible output must be obtained from a given amount of resources.

**Definition:** Production economics is the application of the principles of microeconomics in production. Based on the theory of firm, these principles explain various cost concepts, output response to inputs and the use of inputs/resources to maximize profits and/ or minimize costs. Production economics, thus provides a framework for decision making at the level of a firm for increasing efficiency and profits.

### **Why study production process**

The study of production economics is important in answering the following questions:

1. What is efficient production?
2. How is most profitable amount of inputs determined?
3. How the production will respond to a change in the price of output?
4. What enterprise combinations will maximize profits?
5. What should a manager do when he is uncertain about yield response?
6. How will technical change affect output?

### **Agricultural Production Economics**

It is a sub-discipline within the broad subject of agricultural economics and is concerned with the selection of production patterns and resource use efficiency so as to optimize the objective function of farming community or the nation within a framework of limited resources. It may be defined as an applied field of science wherein principles of economic choice are applied to the use of resources of land, labour, capital and management in the farming industry.

## **Goals of Production Economics**

The following are the goals of agricultural production economics:

1. Assist farm managers in determining the best use of resources, given the changing needs, values and goals of the society.
2. Assist policy makers in determining the consequences of alternative public policies on output, profits and resource use on farms.
3. Evaluate the uses of theory of firm for improving farm management and understanding the behaviour of the farm as a profit maximizing entity.
4. Evaluate the effects of technical and institutional changes on agricultural production and resource use.
5. Determine individual farm and aggregated regional farm adjustments in output supply and resource use to changes in economic variables in the economy.

## **Subject Matter of Agricultural Production Economics**

Agricultural production economics involves analysis of production relationships and principles of rational decision making to optimize the use of farm resources on individual farms as well as to rationalize the use of farm inputs from the point of view of the entire economy. The primary interest is in applying economic logic to problems that occur in agriculture. Agricultural production economics is concerned with the productivity of farm inputs. As such it deals with resource allocation, resource combinations, resource use efficiency, resource management and resource administration. The subject matter of agricultural production economics involves the study of factor-product, factor-factor and product-product relationships, the size of the farm, returns to scale, credit and risk and uncertainty, etc. Therefore, any problem of farmers that falls under the scope of resource allocation and marginal productivity analysis is the subject matter of agricultural production economics.

## **Objectives**

1. To determine and outline the conditions that give the optimum use of capital, labour, land and management resources in the production of crops, livestock and allied enterprises.

2. To determine the extent to which the existing use of resources deviates from the optimum use.
3. To analyse the forces which condition the existing production pattern and resource use.
4. To explain the means and methods in getting from the existing use to optimum use of resources.

## Lecture 2

### Agricultural Production Economics: Basic Concepts

1. Production: The process through which some goods and services called inputs are transformed into other goods called products or output.
2. Production function: A systematic and mathematical expression of the relationship among various quantities of inputs or input services used in the production of a commodity and the corresponding quantities of output is called a production function.
3. Continuous production function: This function arises for those inputs which can be divided into smaller doses. Continuous variables can be known from measurement, for example, seeds and fertilizers, etc.
4. Discontinuous or discrete production function: This function arises for those inputs or work units which cannot be divided into smaller units and hence are used in whole numbers. For example, number of ploughings, weedings and harvestings, etc.
5. Short run production period: The planning period during which one or more of the resources are fixed while others are variable resources. The output can be varied only by intensive use of fixed resources. It is written as
$$Y=f(X_1, X_2 / X_3, \dots, X_n)$$
 where Y is output,  $X_1, X_2$  are variable inputs and  $X_3, \dots, X_n$  are fixed inputs.
6. Long run production period: The planning period during which all the resources can be varied. It is written as
$$Y=f(X_1, X_2, \dots, X_n)$$
7. Technical coefficient: The amount of input per unit of output is called technical coefficient.
8. Resources: Anything that aids in production is called a resource. The resources physically enter the production process.
9. Resource services: The work done by a person, machine or livestock is called a resource service. Resources do not enter the production process physically.

10. Fixed resources: The resources that remain unchanged irrespective of the level of production are called fixed resources. For example, land, building, machinery. These resources exist only in short run. The costs associated with these resources are called fixed costs.
11. Variable resources: The resources that vary with the level of production are called variable resources. These resources exist both in short run and long run. For example, seeds, fertilizers, chemicals, etc. The costs associated with these resources are called variable costs.
12. Flow resources: The resources that cannot be stored and should be used as and when these are available. For example, services of a labourer on a particular day.
13. Stock resources: The resources that can be stored for use later on. For example, seeds. Defining an input as a flow or stock depends on the length of time under consideration. For example, tractor with 10 years life is a stock resources if we take the services of tractor for its entire useful life of 10 years. But it also provides its service every day, therefore it is a flow resources.
14. Production period: It is the time period required for the transformation of resources or inputs into products.
15. Farm entrepreneur: Farm entrepreneur is the person who organizes and operates the farm business and bears the responsibility of the outcome of the business.
16. Farm business manager: Person appointed by the entrepreneur to manage and supervise the farm business and is paid for the services rendered. He/she carries out the instructions of the entrepreneur.
17. Productivity: Output per unit of inputs is called the productivity.
18. Technical efficiency: It is the ratio of the physical output to inputs used. It implies the using of resources as effectively as possible without any wastages.
19. Economic efficiency: It is the expression of technical efficiency in monetary terms through the prices. In other words, the ratio of value of output to value of inputs is termed as economic efficiency. It implies maximization of profits per unit of input.



20. Allocative efficiency: It occurs when no possible reorganization of resources/production can make any combination higher yielding without making other combination less yielding. It refers to resource use efficiency.
21. Optimality: It is an ideal condition or situation in which costs are minimum and/or profits maximum.
22. Cost of cultivation: The expenditure incurred on all inputs and input services in raising a crop on a unit area is called cost of cultivation. It is expressed as rupees per hectare or rupees per acre.
23. Cost of production: The expenditure incurred in producing a unit quantity of output is known as cost of production, for example, Rs./kg of Rs./quintal.
24. Independent variable: Variable whose value does not depend on other variables and which influences the dependent variable, is termed as independent variable, for example, land, labour and capital.
25. Dependent variable: Variable whose value depends on other variables is termed as dependent variable, for example, crop output.
26. Slope of a line: It represents the rate of change in one variable that occurs when another variable changes. Slope varies at different points on a curve but remains same on all points on a given line. It is the rate of change in the variable on vertical axis per unit change in the variable on horizontal axis and is expressed as a number.
27. Total physical product: Total amount of output obtained by using different units of inputs measured in physical units, for example, kg, tonnes, etc.
28. Average physical product (APP): Output per unit of input on an average is termed as APP and is given by  $Y/X$ .
29. Marginal physical product: Addition to total output obtained by using the marginal unit of input and is measured as  $\Delta Y/\Delta X$ .

## Lecture 3

### Production Functions: Meaning and Types

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 the inputs are transformed into outputs will vary among soil types, animals, technologies, rainfall amount and so forth.

**Definition:** Production function is a technical and mathematical relationship describing the manner and extent to which a particular product depends upon the quantities of inputs or services of inputs, used at a given level of technology and in a given period of time. It shows the quantity of output that can be produced using different levels of inputs.

A production function can be expressed in different ways: in written form, enumerating and describing the inputs that have a bearing on the output; by listing inputs and the resulting outputs numerically in a table; depicting in the form of a graph or a diagram; and in the form of an algebraic equation. Symbolically, a production function can be written as

$Y=f(X_1, X_2, X_3, \dots, X_n)$  where  $Y$  is output,  $X_1, X_2, X_3, \dots, X_n$  are inputs. It, however, does not tell which inputs are fixed and which are the variable ones. Since in production, fixed inputs play an important role, these are expressed as:  $Y=f(X_1, X_2/X_3, \dots, X_n)$  where  $Y$  is output,  $X_1, X_2$  are variable inputs and  $X_3, \dots, X_n$  are fixed inputs.

#### Assumptions of Production Function Analysis

1. The production function is defined only for the non-negative values of inputs and outputs.
2. The production function presupposes technical efficiency. This means that every possible combination of inputs is assumed to result in maximum level of output.
3. The input-output relationship or the production function is single valued and continuous.
4. The production function is characterized by i) decreasing marginal product for all factor-product combinations; ii) decreasing rate of technical substitution between any two factors; and iii) an increasing rate of product transformation between any two products.
5. The returns to scale are assumed to be decreasing.
6. All the factors of production and products are perfectly divisible.
7. The parameters determining the firm's production function do not change over the time period considered. Also, these parameters are not allowed to be random variables.

8. The exact nature of any production function is assumed to be determined by a set of technical decisions taken by the producer.

### **Types of Production Functions**

Several types of production functions used in agriculture are as follows:

i) Linear Production Function: Also known as first degree polynomial. It's algebraic form is given by

$$y = a_0 + bx$$

where  $a_0$  is the intercept and  $b$  is the slope of the function. It is not commonly used in research because it violates the basic assumptions of characteristic functional analysis.

ii) Quadratic PF: Also known as second degree polynomial. This type of PF allows both declining & negative marginal productivity thus embracing the second and third stage of production simultaneously.

$y = b_0 + b_1x_1 + b_2x_1^2$  where  $b_0$ ,  $b_1$ , &  $b_2$ , are the parameters. Such PFs are quite common in fertilizer response studies.

iii) Cobb-Douglas PF: It is also known as power production function. It is most widely used PF. It accounts for only one stage of production at a time & cannot represent constant, increasing or decreasing marginal productivity simultaneously.

$Y = b_0 x_1^{b_1}$  where  $b_0$  is efficiency parameters &  $b_1$  is elasticity of production

iv) Mitscherlich or Spillman function

v) Transcendental function

vi) Translog PF

vii) Constant elasticity of substitution (CES) function

viii) Resistance Function

ix) Square root PF: It represents a compromise between C-D & the quadratic PF.

$$y = a_0 + a_1 \sqrt{x} + a_2 x$$

This function gets rid of the limitations of fixed mix of inputs for producing different levels of output inherent in the C-D production function & that of linear isoclines in quadratic function. Thus, this function allows both a diminishing TP in the same way as QF does & for declining MPs at a diminishing rate as the C-D function does.

## Lecture 4

### Laws of Returns: Increasing, Constant and Decreasing

In production one or a combination of the following relationships are commonly observed:

1. Law of constant marginal returns (productivity),
2. Law of increasing marginal returns (productivity) and
3. Law of decreasing marginal returns (productivity)

**1. Law of constant marginal returns (productivity):** It is said to operate when each marginal unit of variable input adds equal quantity of output to the total output. It is applicable over limited range, e.g. one tractor (plus driver) will almost give same output, other things remaining constant.

Fertilizer (X) (in kg)	Total Product (Y) (in kg)	Marginal Product (Returns) ( $\Delta Y/\Delta X$ )
0	1300	-
10	1350	5
20	1400	5
30	1450	5
40	1500	5
50	1550	5

Algebraically,  $\Delta Y_1/\Delta X_1 = \Delta Y_2/\Delta X_2 = \dots = \Delta Y_n/\Delta X_n$

**2. Law of increasing marginal returns (productivity):** It is said to operate when each marginal unit of variable input adds more and more quantity of output to the total output. It is not common in agriculture, e.g. small increase in seed input given the fixed inputs.

Seed (X) (in kg)	Total Product (Y) (in kg)	Marginal Product (Returns) ( $\Delta Y/\Delta X$ )
10	1000	-
15	1025	5
20	1075	10
25	1150	15
30	1250	20
35	1375	25

Algebraically,  $\Delta Y_1/\Delta X_1 < \Delta Y_2/\Delta X_2 < \dots < \Delta Y_n/\Delta X_n$

**3. Law of decreasing marginal returns (productivity):** It is said to operate when each marginal unit of variable input adds less and less quantity of output to the total output. It is widely applicable in agriculture.

<b>Fertilizer (X) (in kg)</b>	<b>Total Product (Y) (in kg)</b>	<b>Marginal Product (Returns) (<math>\Delta Y/\Delta X</math>)</b>
0	500	-
10	1400	90
20	2100	70
30	2600	50
40	3000	40
50	3300	30
60	3500	20

Algebraically,  $\Delta Y_1/\Delta X_1 > \Delta Y_2/\Delta X_2 > \dots > \Delta Y_n/\Delta X_n$

## Lecture 5

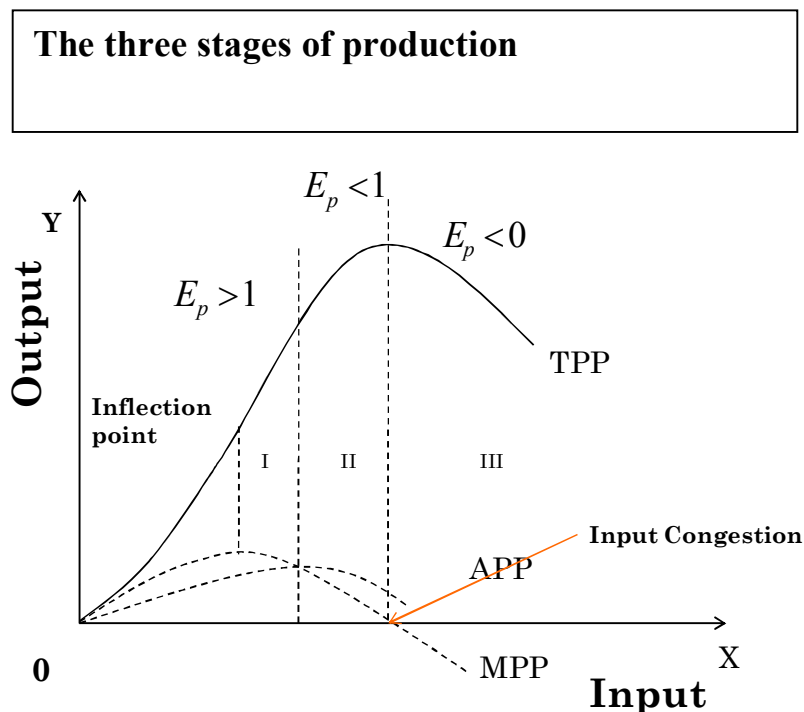
### Factor-Product Relationship

#### Determination of Optimum Input and Output

#### Law of diminishing returns and the three stages of production

The law of diminishing returns describes the relationship between output and the variable input when other inputs are held constant.

**Definition:** If increasing amounts of one input are added to a production process while all other inputs are held constant, the amount of output added per unit of variable input will eventually decrease. It is also known as law of diminishing productivity or the law of variable proportions. Application of the law of diminishing returns to the production concept can result in a production function of classical type. It displays increasing marginal returns first and then decreasing marginal returns.



### **Three stages of production**

The classical production function can be divided into three regions or stages, each being important from the standpoint of efficient resources use.

**Stage-I** occurs when marginal physical product (MPP) > average physical product (APP). APP is increasing throughout this stage, indicating that the average rate at which X is transformed into Y, increases until APP reaches its maximum at the end of Stage-I.

**Stage-II** occurs when MPP is decreasing and is less than APP but greater than zero. The physical efficiency of the variable input reaches a peak at the beginning of Stage-II. On the other hand physical efficiency of fixed input is greatest at the end of Stage-II. This is because the number of fixed input is constant and therefore the output/ unit of fixed input must be the largest when the total output from the production process is maximum.

**Stage-III** occurs when MPP is negative. Stage III occurs when excessive quantities of variable input are combined with the fixed input, so much, that total physical product (TPP) begins to decrease.

**Economic recommendations & production function analysis:** Production function knowledge and the input and output prices information can be used to know the most profitable input and output levels. However, even when price information is not available, some recommendations about the input use can be made from the production function itself.

1. If the product has any value at all, input use once begun, should be continued until Stage –II is reached. That is because physical efficiency of variable resources, measured by APP, increases throughout stage –I.
2. Even if input is free, it will not be used in stage III. Maximum output occurs when Stage II closes. It is of no use applying variable input when TPP starts coming down.
3. Stage II defines the area of economic relevance. Variable input use must be somewhere in stage-II, but exact input amount can be determined when choice indicators (input & output prices) are known.

#### **A. Relationship between TPP & MPP**

1. Since MPP is a measure of rate of change, therefore



- (i) when TPP is increasing, MPP will be +ve,
  - (ii) when TPP is constant MPP will be zero,
  - (iii) when TPP decreases, MPP will be –ve.
2. So long MPP moves upward, TPP increases at an increasing rate.
  3. When MPP remains constant, TPP increases at a constant rate.
  4. When MPP starts declining, TPP increases at a decreasing rate.
  5. When MPP is zero, TPP will be at maximum.

### **B. Relationship between MPP & APP**

1. When MPP is increasing, APP is also increasing. So long as MPP is above APP, the APP keeps increasing.
2. When MPP curve goes below APP curve, APP starts declining, that is, when AP is decreasing the MP is always less than APP.
3. When MP = AP, AP will be at maximum. Here MP curve must intersect AP curve from above at its highest point.

So when      MP > AP      AP↑  
                   MP < AP      AP↓  
                   MP = AP      AP is at maximum.

**Elasticity of production:** The elasticity of production is a concept that measures the degree of responsiveness between output and input. It is independent of the units of measurement.

$$E_p = \frac{\% \text{ change in output}}{\% \text{ change in input}}$$

$$E_p = \frac{\Delta Y / Y}{\Delta X / X} = \frac{\Delta Y / \Delta X}{Y / X} = \frac{MPP}{APP}$$

$E_p > 1$  in Stage I

$0 \leq E_p \leq 1$     *stage II*  
 $E_p$  is negative    *stage - III*    } is based on exact MPPs

The point of diminishing returns can be defined to occur when  $MPP = APP$  that is  $E_p = 1$  (lower boundary of stage II) & this is the minimum amount of variable input that will be used & it occurs when the efficiency of variable input is at its maximum. At the other end,  $MPP$  is zero, therefore  $E_p = 0$ . Thus the relevant production zone is when  $0 \leq E_p \leq 1$ .

The optimum level of variable input is given by:

$$\Delta X_1 \cdot P_{X_1} = \Delta Y \cdot P_y \quad \text{or} \quad \Delta Y / \Delta X_1 = P_{X_1} / P_y$$

**Marginal cost = marginal revenue.**

## Lecture 6

### Factor – Factor Relationship

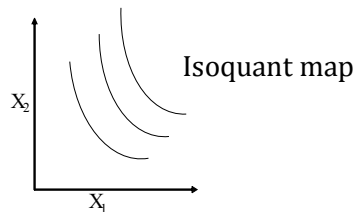
Factor-factor relationship is concerned with the possibilities of substituting one input/factor ( $X_1$ ) for another input/factor ( $X_2$ ) for producing a given level of output. It answers the crucial question of finding out the optimum or least cost combination of two or more resources in producing the given amount of output. The two fold object of factor-factor relationship is

- (i) Minimization of cost at a given level of output.
- (ii) Optimization of output to the fixed factors through alternatives resources combinations.

The functional relationship is  $Y = f(X_1, X_2/X_3---X_n)$

what amounts of  $X_1$  &  $X_2$  should be used to give the lowest cost for producing fixed  $y^0$ , when  $X_3$ .....  $X_n$  are held constant.

**Isoquant (Iso-product curve):** It is defined as the locus of various combinations of two inputs yielding the same level of output. Each point on an isoquant represents the maximum output that can be attained with these input combinations. Isoquant is a convenient device for compressing the 3-dimension picture of a production process into two dimensions.  $X_1 = f(X_2, Y^0)$ .



Properties of isoquants

1. Isoquants have a negative slope,

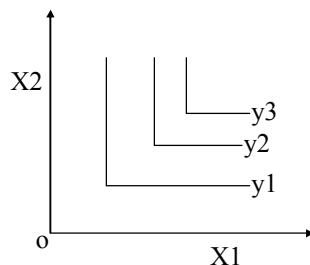
2. Isoquants to right indicate higher output level,
3. Isoquants do not intersect each other,
4. Isoquants are convex to origin showing diminishing MRTS.

**Types of Factor-Factor Relationship:** Many types of production surfaces are possible depending upon the underlying production function. The shapes of the isoquants and production surfaces will depend on the manner in which the variable inputs are combined to produce a particular level of output. Broadly, these are three categories of such combinations of inputs.

- (1) Fixed proportion combination of inputs,
- (2) Constant rate of substitution
- (3) Varying rates of substitution

**(1) Fixed proportion combination**

These represent such products that can be produced if inputs are added in fixed proportion at all levels of production. In this case there is no substitution between inputs and thus there is strict complementarity between the two inputs. Such an isoquant implies that one exact combination of inputs will produce a particular level of output. The inputs which increase the output only when combined in a fixed proportion are known as complementary inputs, e.g. One tractor and one man (driver). No problem in economic decision making. Also called Leontief isoquants.

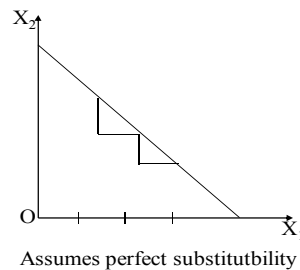


**Substitutes:** Two resources are said to be substitutes when change in price of one leads to a change in demand for another (MRTS is  $-ve$ ).

**Complements:** Resources used together in production. When Price of  $X_1$  increases the demand for  $X_2$  decrease. (MRTS is zero).

**2. Constant rate of substitution:** Such type of a factor-factor relationship gives linear isoquants. The substitution occurs at constant rate i.e. the amount of one input replaced by the other input does not change as the added input increases.

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



### Constant Substitution

$\frac{X_2}{\text{Female labour}}$	$\frac{X_1}{\text{Male labour}}$	$\Delta X_2$	$\Delta X_1$	$\frac{\Delta X_2}{\Delta X_1} \left( \frac{\text{MRTS}}{X_1 X_2} \right)$
10	1	2	1	$2/1=2$
8	2	2	1	$2/1=2$
6	3	2	1	$2/1=2$
4	4	2	1	$2/1=2$
2	5	2	1	$2/1=2$

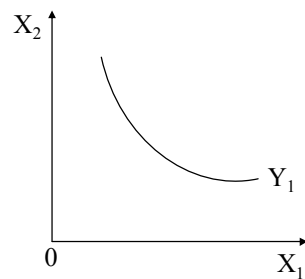
e.g. Two labourers. Decision rule use either of the two depending on the relative prices.

**3. Varying Rate of substitution:** In this there can either be increasing rate or decreasing rate of substitution. In this  $\text{MRTS}_{X_1 X_2}$  varies over iso-product curve. It means that the amount of one input ( $X_1$ ) required to substitute for one unit of another input ( $X_2$ ) at a given level of production

increases or decreases as the amount of  $X_1$  used increases. Substitution at decreasing rate is common in agriculture (N& P or K & L)

$$\frac{\Delta X_{21}}{\Delta X_{11}} > \frac{\Delta X_{22}}{\Delta X_{12}} > \dots \rightarrow \frac{\Delta X_{2n}}{\Delta X_{1n}}$$

$X_1$	$X_2$	$\Delta X_2$	$\Delta X_1$	$\Delta X_2/\Delta X_1$
23	0			
16	1	7	1	7
10	2	6	1	6
5	3	5	1	5
1	4	4	1	4
0	5	1	1	1



Fodder & concentrates

These convex isoquants represent continuous substitution between the two inputs. These are easy to handle mathematically (using calculus).

$$MRTS_{X_1 X_2} = \frac{\Delta X_2}{\Delta X_1}$$

**Marginal rate of technical substitution (MRTS or MRS):** MRTS is defined as the negative of the slope of the isoquant at any point. It is the rate at which two factors of production can be exchanged at a particular level of output and consequently that of the levels of inputs used.

$$\text{Slope of isoquant} = \text{MRTS}_{X_1X_2} = \frac{\Delta X_2}{\Delta X_1} \frac{\text{for(replaced)}}{\text{of(added)}} = \frac{MP_1}{MP_2}$$

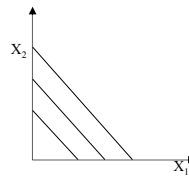
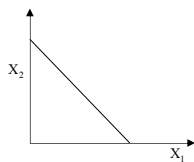
$$dy = \frac{Dy}{DX_1} \cdot dx_1 + \frac{Dy}{DX_2} \cdot dX_2$$

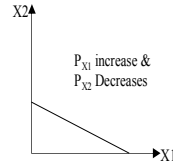
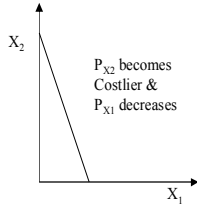
dy = 0 on an isoquant

$$-\frac{dX_2}{dX_1} = \frac{Dy/DX_1}{Dy/DX_2} = \frac{MP_1}{MP_2}$$

**Iso-cost line:** Locus of all possible combination of two inputs which can be purchased with a given outlay or budget.

$$T = P_{X_1} \cdot X_1 + P_{X_2} \cdot X_2 \text{ or } X_1 = \left( \frac{T}{P_{X_1}} \right) - \frac{P_{X_2}(X_2)}{P_{X_1}}$$





Two important points regarding iso-cost line are:

- (i) If prices are same and only outlay changes then iso-cost lines will be parallel to each other.
- (ii) Changes in prices of inputs will change the slope of iso-cost line.

**Computing Least cost combination:** Three methods

**(1) Arithmetical Method:**

output = 85 units

Sr. No.	X1	X2	Cost of X1 @ Rs3.00/unit	Cost of X2 @ Rs4.00/unit	Total outlay
1	8	2	24	16	32
2	6	3	18	12	30
3	5	4	15	16	31
4	4.5	5	13.50	20	33.5
5	3.5	7	10.50	28	38.5

**(2) Algebraic Method:**

$$MRS_{X_1X_2} = \frac{\Delta X_2}{\Delta X_1}$$

$$\text{Price ratio} = \frac{PX_1}{PX_2}$$

$$PX_1 (\Delta X_1) = PX_2 (\Delta X_2)$$

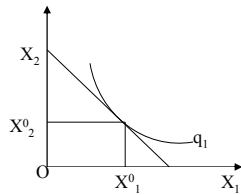
If  $PX_1 (\Delta X_1) > PX_2 (\Delta X_2) \rightarrow$  Increase  $X_2$



If  $PX_1 (\Delta X_1) < PX_2 (\Delta X_2) \rightarrow$  Increase  $X_1$

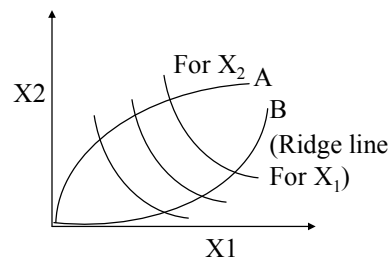
**(3) Graphic Method:**

Slope of isoquant = slope of iso-cost line



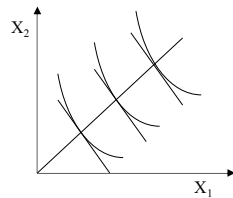
**Iso-cline:** A line or curve connecting the least cost combinations of inputs for all output levels is known as isocline. Isocline passes through all isoquants at points where they have same slope. It shows how the relative proportion of the factors changes as the output is increased. It shows that resources should be used along this line as long as  $MVP > MC$  of resources used.

**Ridge lines:** Represent the points of maximum output from each input, given a fixed amount of the other input. On the ridge lines  $MPP$  is zero. Ridge lines represent the economic relevance within the ridge lines  $MPP_s$  of both the inputs is positive but decreasing.



**Expansion Path:** - There can be numerous isoclines for different possible combinations of input prices. All these sets of prices of inputs do not prevail at any particular given time. A farm manager has to consider only one set of input prices that is most appropriate for the planning period. The isoclines depending upon this set of prices (most appropriate) is called expansion path. At any particular time there is only one expansion path possible.

Thus, the line or curve connecting the points of least cost combination for different levels of output is called expansion path. Expansion path is an isocline on which slope of isoquant (MRTS) equals the slopes of isocost line (price ratio). The expansion path indicates the best way of producing the different levels of output given the input prices & the technology. If expansion path is a straight line through origin, it means inputs will be used in the same proportion at all output levels and hence it is called scale line. It is curved; it implies the inputs will be used in various proportions.



## Lecture 7

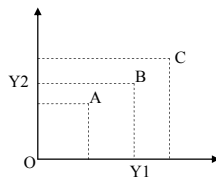
### Product-Product Relationship

**Product-product relationship:** The farmers have limited resources and have a number of enterprises/or enterprise combinations of crops and livestock to choose from. So the question is: How much of what to produce and with what technology. In other words, what combination of enterprises should be produced?

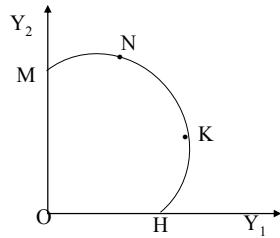
Algebraically,  $y_1 = f(y_2)$

Basic Relationship: The basic product-product relationships are

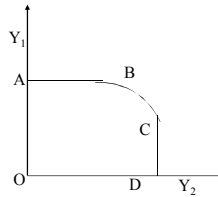
- (i) **Joint Products:** Joint products result from the same production process and the production of one without the other is not possible. For instance, cotton lint & seed, wheat & straw. In such cases the quantity of one product produced decides the quantity of other product. For production decisions, joint products can be treated as one product. Changes in product combinations are possible in long run only (through research).



- (ii) **Complementary Products:** Complementarity between two enterprises exists when with a change in the level of one, the other also changes in the same direction. e.g. Maize after barseem.

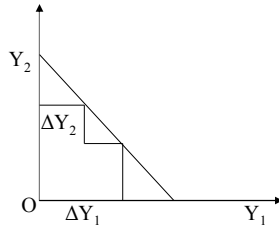


- (iii) Supplementary products: Exists when increase or decrease in one product does not affect the production level of the other product. All supplementary relationships should be taken advantage of by producing both products to the point where the products become competitive.



- (iv) Competitiveness: This relationship holds when increase or decrease in the production of one product affects the production of other commodity inversely. Competitive enterprises compete for farm resources & substitute for each other. When two products are competitive, some amount of one product must be given up to increase the level of other product. MRPS between products is negative. When two products are competitive, they may substitute at constant rate, increasing rate or decreasing rate.

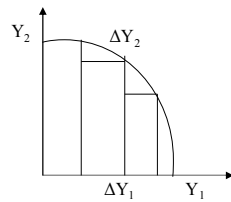
- (a) Constant Rate of Substitution: It means that a unit change in one product is throughout accompanied by the same unit opposite change in the other product e.g. wheat & gram for land.



$\frac{\Delta y_1}{\Delta y_2} = \frac{\Delta y_{12}}{\Delta y_{22}} = \dots = \frac{\Delta y_{1N}}{\Delta y_{2N}}$ . This is normally a short run relationship. When this relationship exists it will be economical to produce only one of the products depending upon the relative prices.

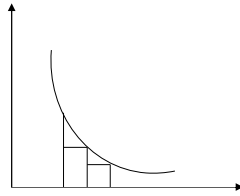
**(b) Increasing Rate of Substitution:** In this each unit increase in the level of one product is accompanied by larger and larger decrease in the level of other product. e.g. wheat & gram will substitute at increasing rate for capital and labour.

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



Here profit is maximum when physical rate of substitution is equal to product price ratio.

$$\frac{\Delta y_{21}}{\Delta y_{11}} > \frac{\Delta y_{22}}{\Delta y_{12}} > \dots > \frac{\Delta y_{2N}}{\Delta y_{1N}}$$



**c) Decreasing Rate of Substitution:** In this case a unit increase in the level of one product is accompanied by lesser & lesser decrease in the level of other product e.g. dairy & crops. Rare in agriculture. If this exists it will be economical to produce only one of the products. Price line will be tangent at only one of the end points of the curve.

Summary:  $\frac{\Delta y_2}{\Delta y_1} > \text{zero}$  – complementary;  $\frac{\Delta y_2}{\Delta y_1} < \text{zero}$  – competitive MRPS  $y_1 y_2$

$\frac{\Delta y_2}{\Delta y_1} = \text{zero}$  – supplementary

## Lecture 8

### Returns to Scale

It refers to the change in output as a result of a given proportionate change in all the factors of production simultaneously. Returns to scale is a long run concept as all the variables are varied in quantity. Returns to scale are increasing, constant or decreasing depending on whether proportionate simultaneous increase of input factors results in an increasing in output by a greater, same or smaller proportion.

#### Hypothetical example of returns to scale

Labour	Capital	Output	Change in output ( $\Delta Y$ )	Nature of returns to scale
0	0	0		
1	1	8	8	Increasing
2	2	17	9	
3	3	28	11	
4	4	38	10	Constant
5	5	38	10	
6	6	58	10	
7	7	68	10	
8	8	76	8	Decreasing
9	9	82	6	
10	10	84	4	

#### Difference between the law of variable proportions and returns to scale

Sr. No.	Law of variable proportions	Returns to Scale
1	Describes the behaviour of output when one input is varied.	Examine the behaviour of output when all inputs are varied at the same time.
2	Some factors of production are constant.	All factors are varied.
3	The proportion among factors varies.	The proportion among factors remains constant.
4	It is a short run production function.	It is a long run production function.
5	Here increasing constant or decreasing returns to a factor are observed.	Here increasing constant or decreasing returns to scale are observed.
6	Increasing returns are due to the efficient utilization of fixed resources as a result of application of sufficient quantity of	Increasing returns to scale are due to scale economies of production.

	variable resource.	
7	Optimum output is the result of best proportion among fixed & variable factors.	The optimum output is the result of optimum size of plant.
8	Diminishing returns are due to over exploitation of fixed factor.	Diminishing returns to scale are due to the operation of diseconomies of scale.
9	$Y = f(X_1 / X_2, X_3, \dots, X_n)$	$Y = f(X_1, X_2, \dots, X_n)$
10	It is a reality.	It is myth.



## Lecture 9

### Farm Management: Definition, Scope and Importance

**Farm Management:** Farm management comprises of two words: ‘farm’ and ‘management’. Literally ‘farm’ means a piece of land where crops and livestock enterprises are taken up under a common management and has specific boundaries. ‘Management’ means the act or art managing.

#### Definitions

- Farm management is defined as the science that deals with organization and operation of the farm in the context of efficiency and continuous profits (**J.N. Efferson**).
- Farm management is defined as the science of organization and management of the farm enterprises for the purpose of securing greatest continuous profits (**G.F. Warren**).
- Farm management is defined as the art of managing a farm successfully as measured by the test of profitability (**Gray**).
- Farm management is defined as the art of applying business and scientific principles to the organization and operation of the farm (**Andrew Boss**).
- Farm management is the decision-making process whereby limited resources are allocated to a number of production alternatives to organize and operate the business in such a way to attain some objectives (**Ronald D. Kay**).
- Farm management is a branch of agricultural economics, which deals with wealth earning and wealth spending activities of farmer in relation to the organization and operation of the individual farm unit for securing the maximum possible net income (**Bradford and Johnson**).
- Farm management, as the sub-division of economics, which considers the allocation of limited resources within the individual farm, is a science of choice and decision-making and thus a field requiring studied judgment (**Heady and Jensen**).

Thus in simple words, farm management can be defined *as a science which deals with judicious decisions on the use of scarce farm resources, having alternative uses to obtain the maximum profit and family satisfaction on a continuous basis from the farm as a whole and under sound farming programmes*. In other words, farm management seeks to help the farmer

in deciding problems like what to produce, how much to produce, how to produce and when to buy and sell and in organization and managerial problems relating to these decisions.

### **Scope and importance of farm management**

Farm Management is generally considered to fall in the field of microeconomics. It deals with the allocation of resources at the level of an individual farm. While in a way concerned with the problems of resource allocation in the agricultural sector, and even in the economy as a whole, the primary concern of farm management is the farm as a unit.

It covers aspects of farm business which have a bearing on the economic efficiency of the farm. thus, the types of enterprises to be combined, the kind of crops and varieties to be grown, the dosage of fertilizers to be applied, the implements to be used, the way the farm functions are to be performed, all these fall within the purview of the subject of farm management. The subject of farm management includes; farm management research, training and extension.

### **Farm Management Research**

- a) delineation of homogeneous type-of farming-areas in various regions of the country,
- b) generation of input-output coefficients and working out comparative economics of various farm enterprises,
- c) formulation of standard farm plans and optimum cropping patterns for different areas and types of farming,
- d) developing suitable models of mechanization and modernization; and
- e) evaluation of agricultural policies having a bearing on development and growth of the farm-firms.

## **Agricultural Production Economics vis-a-vis Farm Management**

Following are the differences between agricultural production economics and farm management.

<b>Sr. No.</b>	<b>Agricultural Production Economics</b>	<b>Farm Management</b>
1	It is a science in which the principles of choice are applied to use of land, labour and management of resources in the farming industry.	It is a science of organization and operation of farm with a view to earn continuous profits.
2	Agricultural production economics is a specialized branch of agricultural economics.	It is an integral part of agricultural production economics.
3	It is microeconomic in its scope as it deals with the problems of farming industry.	It is microeconomic in its scope as it is concerned with the problems of individual farm.
4	It deals with allocative efficiency of the use of resources in agriculture.	It deals with economics efficiency at the farm level.
5	It is an inter-farm study.	It is an intra-farm study.

## **Lecture 10**

### **Typical Farm Management Decisions**

As farm management is the science which concerns with making decisions and choices about combining different enterprises and optimal utilization of resources available, it is necessary to understand the typical farming decisions. Decisions can be classified into organizational management decisions, administrative management decisions and marketing management decisions which are discussed as below:

**1. Organizational management decisions:** These are further sub-divided into operational management decisions and strategic management decisions.

**i) Operational management decisions:** Those decisions, which involve less investment and are made more frequently, are called operational management decisions. The effect of these decisions is short lived. These decisions can be reversed without incurring a cost or with less cost. These decisions are what, how and how much to produce.

**a) What to produce?**

Every farmer has to decide at the beginning of the every crop season about the type of farm commodities to produce with the resources available on the farm. It means whether to produce crops alone or livestock enterprises alone or a combination of crops and livestock enterprises. While selecting the enterprises and their combinations, the farmer always aims at profit maximization.

**b) How to produce?**

Once the decision about the enterprises and their combinations to produce is made, the next immediate operational management decision to be made is with regard to the manner in which resources are combined or the production technology to be chosen. In the selection of resources and their combinations, farmer is concerned with the cost minimization.

**c) How much to produce?**

After having made the above two decisions, now the farmer has to decide about the amount of output to achieve in the production of farm commodities. This implies deciding upon the quantities of various inputs to be used in production as the level of production depends on amount of inputs used.

**ii) Strategic management decisions**

These decisions involve heavy investment and are made less frequently. The effect of these decisions is long lasting. These decisions cannot be altered. However, in the case of reversal of these decisions farmer has to incur high cost. These decisions are also known as basic decisions. Size of the farm, machinery and labour programme, construction of farm buildings, permanent improvements on the farm like development of irrigation facilities, soil conservation, reclamation, etc. are some of the examples of strategic management decisions.

#### **a) Size of the farm**

This decision assumes greater relevance to the farmer because of slow and low rate of capital turnover, but it is very difficult to decide on the most appropriate size of the farm to be operated, as it is influenced by several factors viz., availability of financial resources, state laws, managerial abilities, climate, type of farming, etc. There are advantages and limitations in operating the farm business on different scales. Large farms enjoy low cost of production, whereas productivity is high on small farms. The advantages and disadvantages of operating enterprises on different scales must be ascertained, while making decision on the size of the farm.

#### **b) Machinery and labour programme**

One of the important management problems is to choose appropriate resources and their combinations to produce output with minimum cost. Machinery and labour are substitutes. The availability and requirement of labour, the size of the farm, the financial resources, etc., are important factors in deciding the combination of labour and machinery.

#### **c) Construction of farm buildings**

This decision involves huge capital requirements. Here the decisions are made on construction of farm sheds, poultry sheds, dairy sheds, storage buildings, etc. Once the decision is taken about the design of a farm building and implemented then it cannot be reversed, for it involves high penalty.

#### **d) Irrigation, conservation and reclamation programmes**

All these programmes help in improving soil productivity. Adaptation of these programmes will have long lasting effect on the organization of the farm business. Size of the farm, availability of funds, availability of ground water, etc, influence the decision on development of irrigation facilities. Mulching, bunding, contouring, strip cropping, etc., are the various alternative

measures of soil conservation. Chemical and cultural practices are adapted for soil reclamation. The farmer should choose most appropriate and economical method of conservation and reclamation programmes.

## **2. Administrative management decisions**

Besides organizational management decisions, the farmer also makes several administrative decisions like financing the farm business, supervision, accounting and adjusting his farm business according to government policies.

**a) Financing the farm business:** Majority of the Indian farmers are capital starved, hence they have to depend on borrowed capital. For borrowing, the farmer has to examine the decisions like from whom to borrow, when to borrow and how much to borrow.

**b) Supervision:** To get the desired results on the farm, farmers should keep a close watch on all the activities performed in the production of crop and livestock enterprises.

**c) Accounting:** Farmer should make a decision about the time and money to be allocated for the maintenance of farm records. Farm records provide control over the farm business.

**d) Adjusting the farm production programme:** The decision of allocating farm resources in the production of farm products should be consistent with the price policies of the government. The government as a welfare state exercises its control over production and marketing of farm commodities according to the situation.

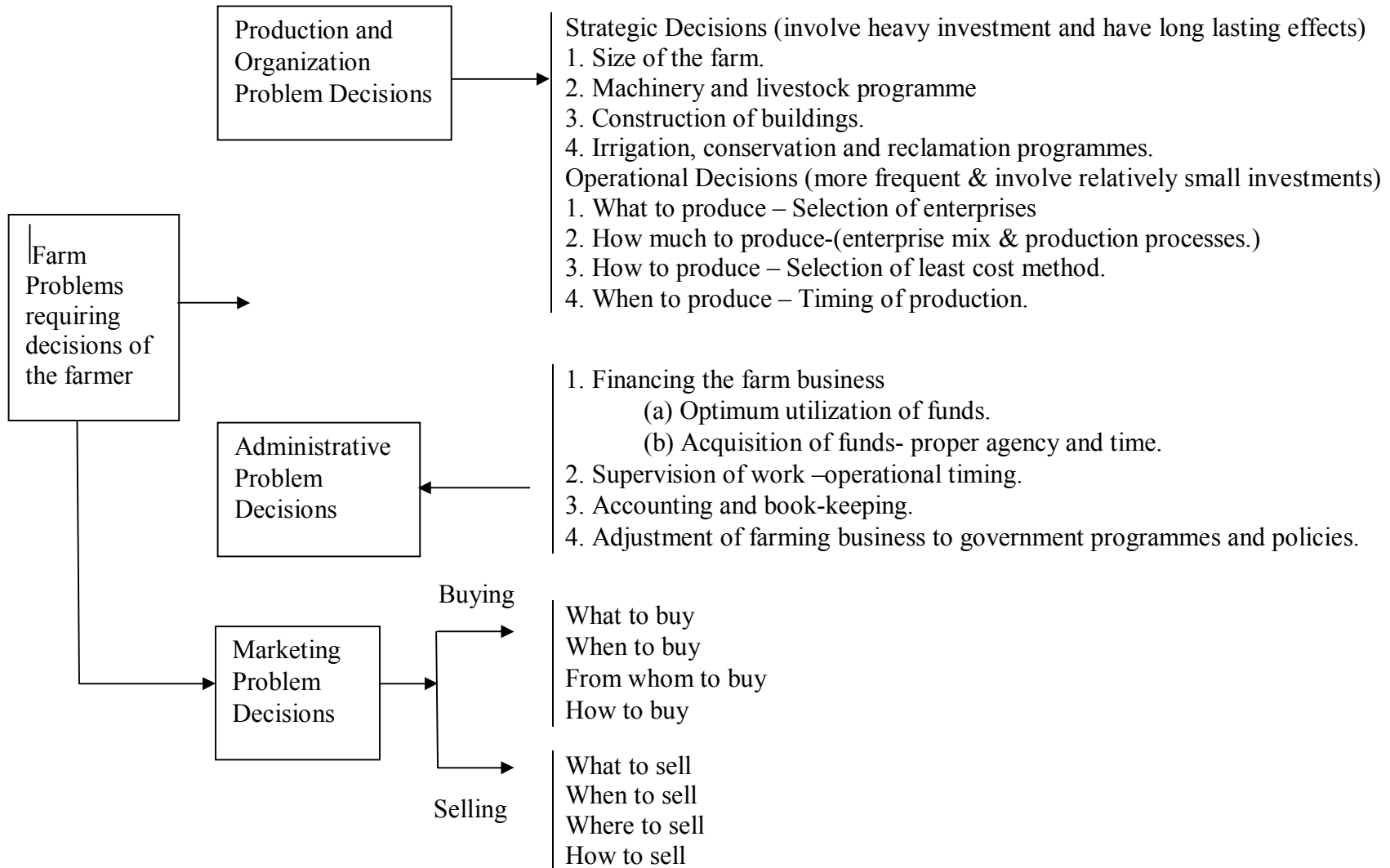
## **3. Marketing management decisions**

Marketing decisions are the most important under the changing environment of agriculture. These decisions include buying and selling.

**a) Buying:** Every farmer makes an attempt to purchase necessary inputs at the least cost. In buying resources, a farmer has to decide the agency, the timing and the quantity to be purchased.

**b) Selling:** Though farm product prices are not under the control of the farmers, yet by adjusting the timing of sales, farmers can obtain better prices. What to sell, where to sell, whom to sell, when to sell and how to sell are the important selling decisions that are to be made by the farmer.

## FARM MANAGEMENT DECISIONS CHART



## **Lecture 11**

### **Cost Concepts in Farm Management**

**Fixed cost (FC):** Fixed costs are those costs which do not change in magnitude as the amount of output produced changes and are incurred even when production is not undertaken. These are also called sunk costs. These could be fixed cash costs such as land taxes, interest, insurance premiums, permanently hired labour, etc. Non-cash fixed costs include depreciation on buildings, machinery interest on capital investment, cost of family labour & management, etc.

**Variable costs (VC):** The costs that are incurred on variable inputs and hence vary with the level of production are called variable costs. Higher the production more will be VC and vice-versa. Expenses on fertilizer, seed, chemical fuel consumption, etc.

Total costs = FC+VC

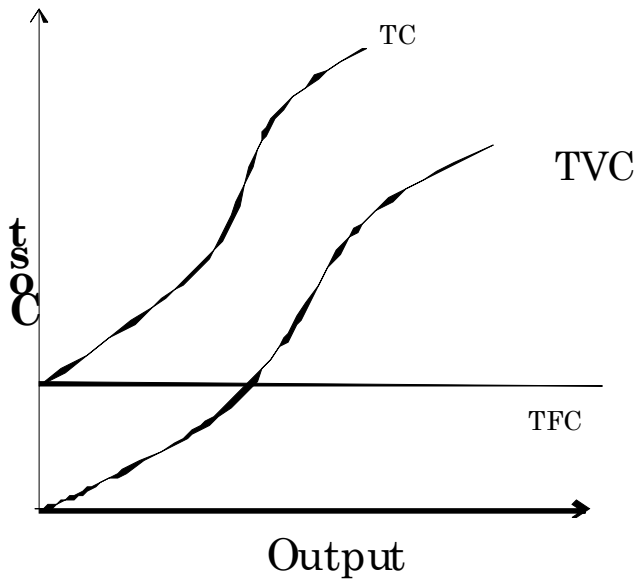
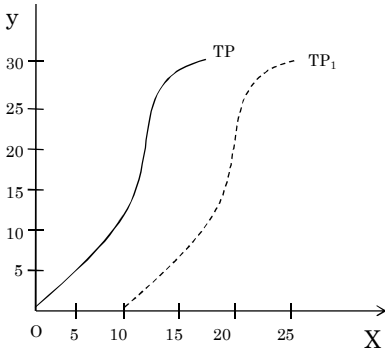
Total costs (TC) are required to compute net revenue (NR)

NR = TR-TC

**Opportunity cost:** Farm resources are limited but these can be put to different uses. When these are used in our product, some alternative usage is always forgone. The opportunity cost is the value of best alternative forgone.

**Cost Function:** Cost function (or TC curves) represents the functional relationship between output and total cost. That is what happens to cost structure when different quantities of a commodity are produced. The cost function can be represented by (i) arithmetically (tabular form), (ii) Geometrically or (iii) Algebraically. Exact nature (curvature) of cost function depends on the corresponding production function provided the prices for inputs do not change with the quality of inputs purchased.





1. Total fixed cost (TFC): The costs incurred on all fixed inputs used in production are known as TFC. These do not change with the output levels & hence represented by a straight line parallel to X axis.

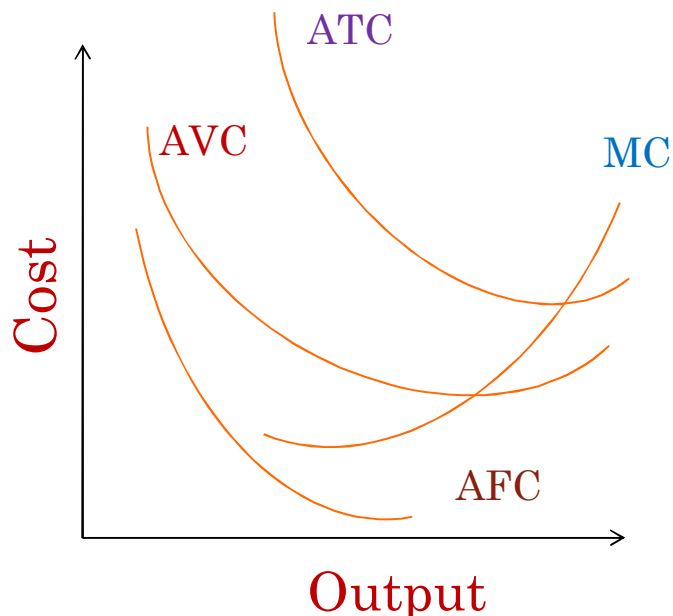
2. Total variable cost (TVC): Refers to the costs of variable input used in production & is computed by multiplying the amount of variable input by the price/ unit of input.

$$TVC = P_x \cdot X$$

Shape of TVC depends on shape of production function.

3. Total cost (TC): TC are the sum of TVC & TFC and are obtained by adding TVC & TFC for different output levels. When no variable input is used (TVC=0) TC = TFC. Shape of TVC & TC are same & depend upon the production function.

$$TC = TFC = TVC \text{ or } TC = TFC + P_x(X)$$



4. Average fixed cost (AFC): It is the fixed cost per unit of output & is computed by dividing TFC by the amount of output at that particular level of output. AFC varies for each level of output and as the output increases, AFC decreases. When output is zero, AFC = TFC. AFC always slopes downward regardless of production function. AFC curve declines continuously & never shows upward movement because after maximum product is achieved, input use beyond this becomes irrational.

5. Average variable cost (AVC): AVC is given by  $\frac{TVC}{Y} = AVC = \frac{P_x \cdot X}{Y} = \frac{P_x}{Y/X}$

AVC varies with the levels of production & its shape depends on production function. The height of AVC depends upon the unit cost of the variable input. Like AFC, AVC cannot be computed when output is zero. AVC is inversely related to APP. AVC falls first due to

economies of large scale production & then rises due to diseconomies of scale in production. AVC (like APP) measures the efficiency of variable input: when AVC is decreasing, efficiency of variable input is increasing; it is at maximum when AVC is at minimum & it is decreasing when AVC is increasing. As the production expands, the AVC declines initially, reaches a lowest point & then bends upwards.

6. Average Total Cost (ATC) =  $\frac{TC}{Y}$  or AFC + AVC; shape of ATC depends upon shape of production function. ATC decreases as output increases, attains a minimum and increases thereafter. ATC is often referred to as 'unit cost' of production – the cost of producing the unit of output. The initial decrease in ATC is caused by the spreading of FC among an increasing number of units of output and the increasing efficiency with which the variable input is used. As output increases further, ATC attains a minimum & begins to increase, as increase in AVC can no longer be offset by decrease in AFC. ATC curve has the same slope as AVC. Difference is that the lowest point in case of AVC reaches earlier as compared to ATC.

7. Marginal Cost (MC): May be defined as the change in TC in response to a unit change in output. That is it is the cost of producing an additional unit of output & is given by  $\frac{\Delta TC}{\Delta Y}$ . Actually a change in TC is always equal to change in VC at a given level of FC. So MC must be worked out by dividing the change in VC by the change in output.

## Lectures 12 &13

### Economic Principles applied to the Organization of Farm Business

#### 1. Cost Principle

$$TC = VC + FC$$

$$\text{Net Revenue} = TR - TC$$

(A) In the short run: Gross revenue (GR) must cover the VC. Maximum net revenue is obtained when  $MC = MR$ . If  $GR < TC$  but  $> VC$ , guiding principle should be to keep increasing production as long as  $MR > MC$ .

In the short run,  $MC = MR$  point may be at a level of input use that may involve a loss instead of profit. Yet at this point loss will be minimized. This situation of operating the farms when  $MR$  is  $> AVC$  but  $< ATC$  is common in agriculture. This explains why farmers keep on doing farming even when they run into losses.

(B) In the long Run:  $GR$  should be  $> VC + FC = TC$ . For taking production decision in such a situation, one should go on using resources as long as added returns remain greater than added total costs. Here, the object is to maximize profits instead of minimizing the losses.

#### 2. Law of Equi- Marginal Returns (Special case of substitution)

When resources are unlimited, farmer can produce all products under the rule,

$\text{Added returns} > \text{Added costs}$
---

But resources are limited, expansion of one enterprise requires contraction of other. The big question is which enterprise combination will give the greatest income? Such an optimum choice of enterprises is made based on the principle of equi-marginal return or the opportunity cost principle. Profit will be the greatest if each unit of labour, capital and land is used where it adds the most to the returns. In other words, this principle lays down: the best combination of enterprises or practices will be where limited resources are allocated in a manner that one cannot change the use of a simple unit without reducing the income. Thus, the resources should be used where they give not the highest average returns but the greatest marginal returns. Thus, the best combination of enterprises is obtained not when we select profitable crops but most profitable crops. The profitability of an enterprise depends on the price of the product, the direct costs

attached to it & the amount of product sacrificed as one enterprise gets replaced with other. Budgeting & programming techniques take this principle into account for working out an optimum plan.

**Example:** A farmer has Rs 5000 to invest on crops, dairy or poultry. What amount of capital he should invest on each enterprise to get highest profit?

Marginal Return to capital on these enterprises are

Marginal Return (MR) (Rs)			
Capital used (Rs)	Crops	Dairy	Poultry
1000	1300	1400	1500
2000	1300	1200	1250
3000	1200	1100	1100
4000	1200	900	1000
5000	1100	800	900
Total Return from Rs 5000	6100	5400	5750
Net Returns	1100	400	750
Av. Returns used/rupee Invested	1.22	1.08	1.15

The marginal return will however dictate spending as

	Amt	Enterprises	Add Return
1 <sup>st</sup>	1000	Poultry	1500
2 <sup>nd</sup>	1000	Dairy	1400
3 <sup>rd</sup>	1000	Crops	1300
4 <sup>th</sup>	1000	Crops	1300
5 <sup>th</sup>	1000		1250
TR from	5000		6750

#### 4. Opportunity Cost Principle:

When resources are limited and there are more than one enterprise where farmer can invest. When resources are used in one product some alternative is always forgone. The opportunity cost is the value of next best alternative forgone. The value of one enterprises sacrificed is the cost of producing another enterprise. This principle thus refers to the advantages (returns) which might have been obtained from any factor if it had not been used in producing that commodity, but

would have been used for other next best purpose. Thus, it is the cost equivalent to the returns from next best alternative forgone.

## **5. Time Comparison Principle**

There are two types of investments: (1) Investments on operating inputs & (2) Investment on capital assets (land, farm building, machinery, equipment, etc). Analysis of these investments involves not only the comparison of costs and returns associated with it, but also the timings of occurrence of costs & returns. The costs & returns from investments in operating resources occur with a production period of a year or less. The marginal principles are used to determine the optimum level of operating resources & there is no need to bring in time element here. But in case of capital assets where the costs & returns are in different time periods and also capital expenditure involves costs & returns over time (orchards). Some expenditure may be recurring & some non- recurring. To examine the profitability of these investments it requires the recognition of time value of money. Money has time value for the following reasons.

- (1) Earning power of money: represented by opportunity cost of money (rate of interest )
- (2) Inflation – purchasing power of money varies inversely with the price level. A rupee earned a year from now is less valuable than a rupee earned today.
- (3) Uncertainty: Investment deals with future & future is uncertain. Investments are made with the expectation of receiving a stream of benefits in the future.

Thus, farm management involves dynamic adjustments in the organization & operation of farm business by taking into account (a) time element in the valuation of present value of future incomes by discounting future returns.

For discounting one needs to know the future & the capital position of the farmer. This implies the exact future income / cost should be known. Capital position of the farmer affects the interest rate to be used for discounting and the (b) risks & uncertainties in farm operations over time (natural calamities, price fluctuations, technical changes). Two aspects of the problem are considered under such situations: (a) Growth of a cash outlay over time i.e. compounding & (b) Discounting of future incomes.

(1) **Compounding:** Compounding is the procedure to find the future value of a present sum, given the earning power (interest rate) of money & the frequency of compounding. e.g. Rs 100 @ 10% interest rate after 4 years.

1<sup>st</sup> year – 100+10 =110; 2<sup>nd</sup> – 110@10% = 110+11=121; 3<sup>rd</sup> year- 121@10@ = 121+12.10 = 133.10 4<sup>th</sup>: 133.10@ 10% = 133.10+13.31 = 146.41

$$S = P (1+i)^n = 100 (1+0.10)^4 = 100 * 1.4641 = 146.41$$

(2) **Discounting:** is the procedure where the present value of the future income is determined.

$PV = \frac{P}{(1+i)^n}$  ; P is the amount to be received in future, PV is the present value e.g. Rs 5000 to

be received after 3 years i =10%

$$PV = \frac{5000}{(1+.10)^3} = \frac{5000}{1.331} = 3756.57$$

For unlimited capital use market rate of interest. And for limited capital use the r that capital may fetch for the farmer. Law of diminishing returns applies to agriculture in general but its operation can be postponed under the following conditions: (i) Improved technology (2) New soils & (3) Scarcity of Capital (as on stage I) – all lead to the produce of increasing returns.

Reasons for law of diminishing returns in agriculture: (1) Excessive dependence on weather, (2) less scope for division of labour, farmer is the labour manager & capitalist (3) Less scope of machinery (4) cultivation of inferior/ marginal lands (5) Continuous cultivation leading to fertility loss.

Example: Analysis of time value of money in purchasing a tractor: A farmer wants to purchase a tractor he has two options (1) purchase a new tractor 2,50,000 that will last 10 years & (2) purchase an old tractor worth 1,50,000 & replace it after 5 years with another old tractor worth 1,50,000.

(A) Farmer with unlimited capital : Has the opportunity of lending money @ 5%

$$PV = \frac{150000}{(1.05)^5} = 1,17,600$$

So 2, 50,000 V/S D 15000 + 117600 = 2, 67,600

(B) With limited capital: Has on opportunity of investing in poultry & earning 15% a year.

The opportunity cost of not using money for poultry is

$$PV = \frac{1,50000}{(1.15)^5} = 74550$$

So his comprises is 150000 + 74550 = 224550

New tractor: 2, 50,000

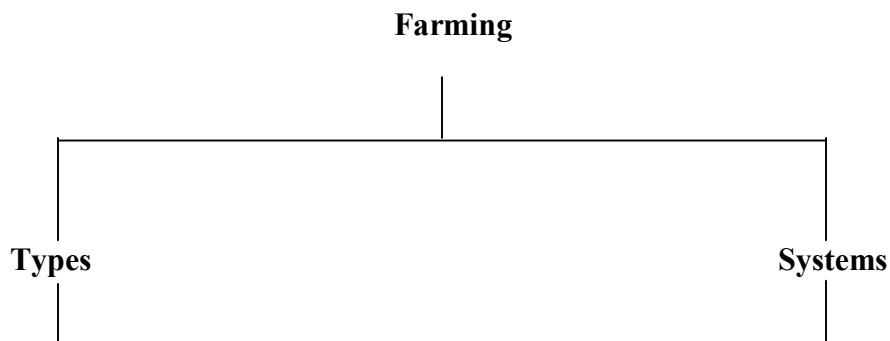


# Lecture 14

## Types and Systems of Farming

### Classification of farming

The 'types of farming' and the 'systems of farming' are two different terms. Some western farm economists have used the terms, type and system interchangeably. Though the distinction between the two is not very clear, yet some experts have tried to differentiate these. The 'system of farming' is generally used to denote the ownership of land, farm resource management and other managerial decisions. It may be cooperative farming, or tenant farming or the state farming, etc. The 'types of farming' refers to the methods of farming and to different practices that are used in carrying out farming operations. Johnson defined it as 'when farms in a group are quite similar in the kinds and proportions of the crops and the livestock that are produced and in the methods and practices followed in production, the group is described as a 'type of farming''. The flow chart given below details out various types and systems of farming.



**1. Diversified including marginal**

**2. Specialised**

**3. Mixed**

**4. Ranching**

**5. Dry**

**1. Co-operative**

**2. Peasant**

**3. State**

**4. Capitalistic**

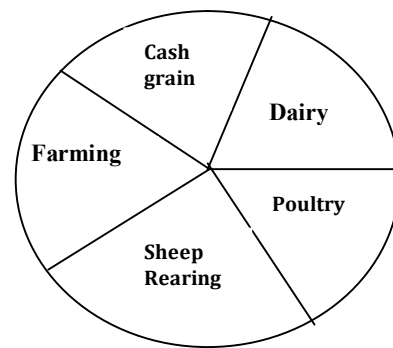
## A. Types of farming

Natural, economic and to some extent social factors determine the type of farming in an area. Within the restraining influence of natural factors, economic factors- relative prices of farm products, resources of the farmer, transport facility, farm size, land value and technological developments influence the type of farming practiced in a region and set the proportion of area under each enterprises. Religious beliefs and social background also play some part in following the type of farming on the farm.

### (1) Diversified or General farm

A farm on which no single product or source of income equals as much as 50% of the total receipt is called a diversified or general farm. On such a farm, the farmer depends on several sources of income.

*Sources of Income*



### Advantages of Diversified farming

1. Better use of resources. Better use of land through adoption of crop rotations, steady employment of farm and family labour and more profitable use of equipment are obtained in diversified farming.
2. Business risk is reduced due to crop failure or unfavorable market prices.
3. Regular and quicker returns are obtained from various enterprises.

### Disadvantages of Diversified Farming

1. Marketable produce is insufficient unless the producers arrange for the sale of their produce on co-operative basis.

2. Because of varied jobs in diversified farming, a farmer can effectively supervise only limited number of workers.
3. Better equipping of the farm is not possible because it is not economical to have expensive implements and machinery for each enterprise.
4. There are chances when some of the leaks in farm business may remain undetected due to diversity of operations.

Under Indian conditions, the advantages of diversified farming far outweigh any consideration for specialized farming. As a rule, crop-dairy type of diversified farming is followed, because it offers more economical use of land, labour and capital and permits safest possible way to withstand adverse weather conditions or violent price fluctuations. Very often complementary relationships are observed among enterprises, which contribute to increased farm production and profitability.

## **(2) Specialised farming**

A specialized farm is one on which 50% or more receipts are derived from one enterprise. Income is sale plus produce used at home.

### **Conditions for Specialization**

- (i) Where there are special market outlets,
- (ii) Where economic conditions are fairly uniform for a long period,
- (iii) Where an enterprise is not much affected by abnormal weather conditions, e.g., poultry farm.

### **Advantages of Specialised Farming**

1. *Better use of land* - It is more profitable to grow a crop on a land best suited to it. For example, jute cultivation on a swampy land.
2. *Better Marketing* – Specialization allows better assembling grading, processing, storing, transporting and financing of the produce.
3. *Better management* – The fewer enterprises on the farm are liable to be less neglected and sources of wastage can easily be detected.
4. *Less equipment and labour are needed* - A fruit farmer needs only special machinery and comparatively less labour for raising fruits.
5. *Costly and efficient machinery can be kept* – A wheat harvester and combine can be maintained in a highly specialized wheat farm.

6. *Efficiency and skill are increased* - Specialization allows a man to be more efficient and expert at doing a few things.

### **Disadvantages of Specialized Farming**

1. *There is greater risk* – Failure of crop and market together may ruin the farmer.
2. *Productive resources*-Land, labour and capital are not fully utilised.
3. Fertility of soil cannot properly be maintained for lack of suitable rotations.
4. By-products may not be fully utilized for lack of sufficient livestock on the farm.
5. Farm returns in each are not generally received more than once a year.
6. General knowledge of farm enterprises becomes limited.

### **(3) Mixed Farming**

Mixed farming is a type of farming under which crop production is combined with livestock raising. The livestock enterprise is complementary to crop production so as to provide a balanced productive system of farming. When the livestock begin to compete with crops for the same resources, the relationship between the two enterprises changes from complementary phase to competitive nature.

In India mixed farming offers the following advantages:

1. Milch cattle provide draught animals for crop production and rural transport.
2. Mixed farming helps in the maintenance of soil fertility. Crops cannot be grown successfully without the use of manure. The most readily available supply of plant food is farmyard manure. But unfortunately, a large part of this is used as a fuel resulting from pressure of population on the land.
3. It tends to give a balanced labour load throughout the year for the farmer and his family.
4. It permits proper use of the farm by-products.
5. It provides greater chances for intensive cultivation.
6. It offers higher returns on farm business.

### **(4) Ranching**

A ranch differs from other type of crop and livestock farming in that the livestock grazes the natural vegetation. Ranches are not utilized for tilling or raising crops. The ranchers have no land of their own and make use of the public grazing land. A ranch occupies most of the time of one or more operator. Ranching is followed in Australia, Tibet and in certain parts of India. An

average Australian sheep farm covers an area of about 100 square miles and there are some farms as large as 1,000 square miles.

### **(5) Dry Farming**

Farmers in dry and precarious tracts, which receive 50 cm or less of annual rainfall, struggle for livelihood. The major farm management problem in these tracts, where crops entirely depends upon rainfall, is the conservation of soil moisture.

## **B. Systems of Farming**

**Conditions determining the system of farming:** Farm tenancy, farm ownership, group farming, economic use of land, and incentives to co-operate are some of the conditions conducive to the adoption of system of farming. An analysis of the system of farming shows that it is closely associated with the type of farming in so far as the type of crops and livestock raising are concerned.

**1.Co-operative farming:** Co-operative farming is divided into two classes: i) Co-operative joint farming & ii) Co-operative collective farming.

**Meaning of Co-operative Farming:** Co-operative farming means a system under which all agricultural operations or part of them are carried on jointly by the farmers on a voluntary basis, each farmer retaining right in his own land. The farmer would pool their land, labour and capital. The land would be treated as one unit and cultivated jointly under the direction of an elected management. A part of a profit would be distributed in proportion to the land contributed by each farmer and the rest of the profit would be contributed in proportion to the wages earned by each farmer. If the farmers are not willing to have a full scale co-operative farming, they can secure some of the economics by joining a particular form of co-operative organization namely, co-operative purchasing, co-operative better farming, co-operative selling, etc.

- (i) *Co-operative joint farming Society:* The ownership is retained by the individuals, but the land is cultivated jointly.
- (ii) *Co-operative Collective farming:* In collective farming, the members of collectives surrender their land, livestock and head stock to the society. The collectives cannot refuse to admit other members of required qualification. The members work together under a management committee elected by themselves. The committee directs farm management in matter of allocation of work, distribution of income and

marketing surpluses and put all members into labour to see that the work is done efficiently. The payment to the workers is in terms of "work day units". A standard quota for each kind of farm operation is fixed in relation to one working day and the amount of work done by each farmer in a day is calculated accordingly, both in respect of quality and quantity. An unskilled worker has to put in more hours than the skilled one to fill his quota of work day. In India, the co-operative collective farming societies are ordinary societies of landless labourers to whom government land is given for cultivation. In this type, the labourers have no land of their own which they can pool, they primarily pool their labour.

**(2) Peasant Farming:**

Peasant farming is concerned with peasant relation to land. The Zamindari Abolition Act of government has given the right of ownership to practically all the peasant-operators in the country. Peasant farming has given them opportunities to organize and operate their farms in their own way and get due reward for their labour and capital. Besides, peasant farming encourages them to maintain and develop the fertility in the occupation of land with social prestige attached to the ownership.

**(3) State farming:**

Under this system of farming, the farms are managed by government. The agricultural labourers are paid wages on weekly or monthly basis in accordance with the wages fixed under Minimum Wages Act.

**(4) Capitalistic farming:**

The capitalistic farming is based on the capital provided by the owner of the farm in carrying out of farm operations. Such type of farming is practiced where landlordism exists as in England or the U.S.A. In India, this type of farming is seen in sugarcane area where factory owners have their own farms. On these farms, five factors of productions namely, land, labour, capital, management and entrepreneurship are in evidence. The manager is a salaried person and the entrepreneur takes risk and gets profit or may sustain loss.

## **Lectures 15 & 16**

### **Farm Planning and Budgeting**

#### **A) Farm planning**

Farm planning refers to setting the objectives and actions to be taken in directing or controlling the organization of farm business and it precedes all other managerial functions on the farm to achieve the desired results. It is deciding in advance, the production management problems viz., what to produce, how to produce, when to produce; financial management problems viz., how to borrow, how much to borrow, when to borrow, where to borrow, and marketing management problems viz., where to buy and sell, when to buy and sell, how to buy and sell, etc. Farm planning governs the survival progress and prosperity of farm organization in a competitive and dynamic environment. It is a continuous and unending process. Farm planning is as old as farming itself but mainly it used to be informal planning. With agriculture becoming more complex business, the scientific planning which is systematic, written and based on the best information available and aimed at achieving maximum satisfaction for the farming family from the given resources is needed. Farm planning has to incorporate changing technological developments, physical and economic situations and price structures, etc. ***Thus, farm planning may be defined as the process of making decisions regarding the organization and operation of a farm business so that it results in a continuous maximization of net returns of a farm business.***

#### **Importance of farm planning to farmer**

It helps the farmers in the following manner:

1. Choose different farm activities suited to the given farm conditions.
2. Look into the future and decide on suitable course of action.
3. Select appropriate enterprise combinations that results in the better use of resources.
4. Timing various jobs and operations for smooth conduct of operations without competition.
5. Avoid wastages that occur in the resource use.
6. Provide guidance and flexibility for ensuring better use and growth of the farm business.
7. Provide allocation of resources for producing the requisite products for marketing and household consumption.

*Thus farm planning may be deemed as an educational tool to bring about desirable organizational changes on the farm to increase the farm income of the farming family.*

### **Objective of farm planning**

The ultimate objective of farm planning is the improvement in the living standards of the farmers and immediate goal is to maximize the net incomes from the farming operations through improved resource planning. Other secondary objectives of farm planning could be secure incomes, minimizing risk or minimizing labour requirements.

### **Types of farm plans**

Farm plans are categorized into two sub-groups viz., simple farm plan and complete farm plan. Simple farm plan implies planning for minor changes or for a particular enterprise. Complete farm planning envisages more number of changes in the existing organization. It is adopted for the farm as a whole.

### **Characteristics of good farm plan**

The following are the characteristics of a good farm plan:

1. Plans should aim at efficient utilization of all the available resources on the farm.
2. Plans should be flexible i.e., they should be adaptable to changing environmental conditions.
3. Farm plans should be simple and easily understood.
4. Considering the available resources, farm plans should ensure balanced production programme consisting of food crops, commercial crops and fodder crops.
5. The production programme included in the farm plan should aim at improving soil fertility.
6. Farm plans should facilitate efficient marketing of farm products.
7. It should take into account up-to-date technology.
8. Farm plans should consider the goals, knowledge, training and experience of the farmers, and their attitude towards risk.
9. Farm plans should avoid too risky enterprises.
10. Farm plans should provide for borrowing, using and repaying the credit.

### **Limitations of farm planning**

Farm planning is considered time consuming and expensive exercise. Good farm plans should be based on the actual recorded facts, particularly giving the data on the availability and requirement of resources. The records provide adequate information for planning process, but it



is unfortunate to note that relevant farm records are not being kept by the farmers. The pertinent information on farms particularly in respect of climate, water supply, markets, etc., is not found in the required form. The sources of data for diagnosis and planning are also lacking. As a result, farm planning is not effectively formulated and implemented. Therefore, farm standards derived from research stations and efficient farms in the locality should form the basis for scientific planning. Data from research stations should be continuously used for this purpose.

### **Tools of farm planning**

1. Production function models, 2. Farm budgeting techniques, 3. Linear programming, 4. Operational research techniques, 5. Integer programming, 6. Dynamic programming, 7. Non-linear programming

### **B) Farm budgeting**

Farm plan is a programme of total farm activity drawn up by the farmer in advance. It should show the crops to be grown; farm practices to be followed; combination of other enterprises; use of labour, investments to be made on the farm, etc. The expression of farm plan in monetary terms i.e. by the estimation of receipts, expenses and net income, is called farm budgeting. In other words, farm budgeting is a process of estimating costs, returns and net profit of a farm or a particular enterprise. Farm budgets are classified into enterprise budget, partial budget and complete budget or whole farm budget. Farm budgeting is a method of examining the profitability of alternative farm plans.

#### **1. Farm enterprise budget**

Commodity production on the farm is called farm enterprise. Farm budgets can be developed for each potential enterprise. Enterprise budgets are prepared in terms of a common unit i.e., acre, hectare, for a crop, one head of livestock, etc. This facilitates easy comparison among the enterprises. Enterprise budget is the estimation of expected income, costs and profit for an enterprise.

#### **Organization of enterprise budget**

It consists of three elements viz., income, costs and profitability. Income is computed by estimating the expected output and expected price. The estimated output is based on the average price expected in future. In order to estimate the variable costs we need information on quantity of inputs used and the prices at which they are purchased. Fixed costs to be included in enterprise budget are land revenue, depreciation, interest on fixed capital and rental value of owned land.

**Table: Enterprise Budget for Pea**

Sr. No	Particulars	Per bigha			Per ha		
		Quantity	Rate(₹)	Value(₹)	Quantity	Value (₹)	
<b>A</b>	<b>Variable cost</b>						
1	Seed (kg)	22	33	726	275	9075	
2	Seed treatment			18		225	
3	FYM (q)	7.50	162	1215	93.75	15187.5	
4	Fertilizers						
i)	IFFCO mixture (kg)	13	10.70	139.10	162.50	1738.75	
ii)	Urea (kg)	6	6	36	75	450	
5	Plant protection			418		5225	
6	Bullock labour (days)	2	500	1000	25	12500	
7	Human Labour (man days)						
i)	Field preparation	3	150	450	37.50	5625	
ii)	Seed preparation & sowing	3	150	450	37.50	5625	
iii)	Manuring	3	150	450	37.50	5625	
iv)	Interculture	11	150	1650	137.50	20625	
v)	Irrigation	4	150	600	50	7500	
vi)	Spraying	3	150	450	37.50	5625	
vii)	Harvesting/Picking, packing & transportation	7	150	1050	87.50	13125	
viii)	Total human labour of which	34		5100	425	63750	
i)	Family labour	22	150	3300	275	41250	
ii)	Hired Labour	12	150	1800	150	22500	
8	Sub total (1 to 7)			8652.10		108151.3	
9	Interest on working capital			115.36		1442.02	
<b>10</b>	<b>Total variable cost(A=8+9)</b>			8767.46		109593.3	
<b>B</b>	<b>Fixed cost</b>						
i)	Rental value of land			5000		62500	
ii)	Interest on fixed capital			648		8100	
iii)	Depreciation			810		10125	
	<b>Total fixed cost</b>			6458		80725	
<b>C</b>	<b>Total cost (A+B)</b>			15225.46		190318.3	
<b>D</b>	<b>Production and Returns</b>						
1	Production (q)			10.75		134.375	
2	Average price (₹/kg)			22		22	
3	By product (q)			1.02		12.75	
4	Average price (₹/kg)			15		15	
<b>5</b>	<b>Gross Returns</b>			25180		314750	
<b>6</b>	<b>Net Returns (₹)</b>			9954.54		124431.70	

## **2. Partial budgeting**

Partial budgeting refers to the estimating the outcome or returns for a part of the business, i.e. one or a few activities. Partial budgeting is a statement of anticipated changes in costs, returns and profitability for such a minor modification on the farm. When a farmer contemplates few modifications or minor changes in the existing organization of the farm business, partial budgeting technique is employed. It is similar to that of marginal analysis, wherein the changes in costs and returns resulting from proposed modifications are alone considered. It consists of four important elements viz., added costs, added returns, reduced returns and reduced costs. Partial budgeting technique is generally used to evaluate the profitability of input substitution, enterprise substitution and scale of operation.

**1. Added costs:** Additional costs are incurred, if the proposed modification is the introduction of a new enterprise or increase in the size of the existing enterprise.

**2. Added returns:** Additional returns could be received when the proposed modification is the addition of a new enterprise, or increase in the size of the existing enterprise or adoption of technology that results in higher productivity.

**3. Reduced returns:** Decrease in the returns is observed when the proposed modification involves the elimination of an existing enterprise or reduction in the size of the existing enterprise.

**4. Reduced costs:** Decrease in the costs is found when the proposed modification involves the elimination of existing enterprise or reduction in the size of the enterprise or adoption of a technology that uses fewer amounts of resources.

## **3. Complete Budgeting**

It is a method of estimating expected income, expense and profits for the farm as whole. Complete budgeting is employed when farmers want to overhaul the entire farm business.

**Steps in farm planning and budgeting:** The sound farm plan should be generally feasible, acceptable, and adaptable. To make the farm plan successful, the following steps should be adopted with relevance to given farm and its resources.

1. Statement of objective.
2. Diagnosis of the existing organization
3. Assessment of resource endowments on the farm.
4. Identification of enterprises to be included.

5. Preparation of enterprise budgets.
6. Identification of risks, and
7. Preparation of a plan.

**1. Statement of objective:** The objective of the farmer may be profit maximization or cost minimization. In selecting enterprises and their combinations, the farmer aims at maximization of profits. On the other hand, while choosing resources and their combinations, he aims at cost minimization.

**2. Diagnosis of the existing organization:** Diagnosis and prescription are the two important components of planning. The planner has to examine the existing organization of farm business carefully and identify the weaknesses or defects or loopholes in the current plan. Once mistakes are identified, corrective steps can be taken in future. Farm plans primarily prescribe remedies for the defects of the existing plan.

**3. Assessment of resource endowment on the farm:**

**a) Land:** Here there is a need to spell out the land holding area, type of land i.e. wet land or dry land, crops grown, type of soils available, topography, texture, fertility status, drainage, soil and water development, soil and water conservation methods, etc.

**b) Labour:** The extent of family labour available with the farmer viz., women, men and children along with their age, household work and farm work done by them should be indicated. Permanent labourers if any engaged by the farmer, type of work done and amount of remuneration paid should be indicated. Labour supply, in the village and demand for labour for different crops in different seasons should be assessed. The supply position with reference to livestock should be assessed correctly.

**c) Capital:** Working capital required for raising crops should be indicated. Owned funds available and the amount of funds borrowed, from different sources, interest paid, etc., need to be clearly specified. Specification of repayment dates, terms and conditions, etc., is also required. Fixed capital relates to information on farm buildings, farm equipment, farm machinery, etc.

**d) Organization:** The farmer's knowledge in farming, his expertise, his experience in farming and confidence in adapting new potential technology should be assessed. Based on this information relevant farm plan should be devised. If the farmer is risk-averse, farm plans, which provide stable income under risk, should be generated.

**e) Irrigation sources:** Availability of different sources of irrigation, area covered under different sources, period of availability of irrigation, quantity of irrigation water available, crop demands

for irrigation water, accessibility of land to the irrigation sources such as canal and tank, etc., should also be indicated. In addition to this cost of irrigation needs to be mentioned.

**4. Identification of enterprises to be included:** List of enterprises not only grown by the farmer but also enterprises grown in that area and also crop rotations are identified. Estimate the input-output coefficients in terms of acre or hectare or head of livestock for all the enterprises, which we propose to include. Information on input and output prices should be collected so as to work out the costs and returns.

**5. Preparation of enterprise budgets:** Estimate the income, cost and profitability of each enterprise to be included in the plan. The preparation of enterprise budgets facilitates comparison of profitability of different enterprises.

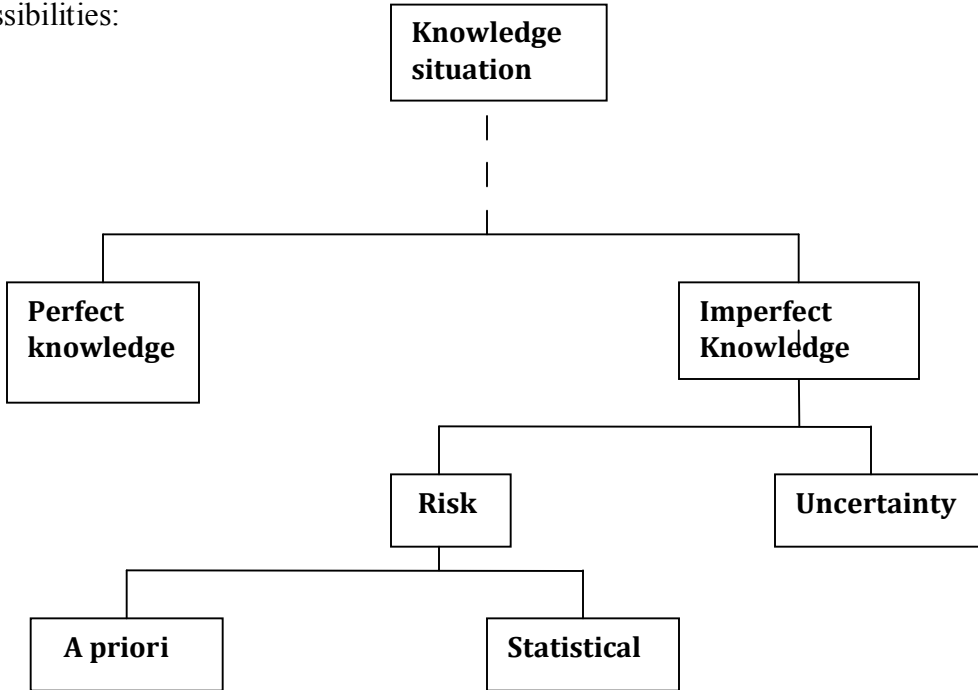
**6. Identification of risks:** List out all types of risks viz., production risk, weather risk, technological risk, institutional risk, marketing risk, etc., faced by the farmers. Particularly the incidence of pests, rodents and diseases, frequency of drought occurrence over time, cyclones, floods and their havoc caused to farm plans. Marketing risks comprising of risk emanating from price fluctuations and failure of markets to arrest the malpractices of middlemen should be indicated.

**7. Preparation of a plan:** The first step is indentifying the scarcest resources and selecting that enterprise which yields maximum returns per unit of scarcest resource. This process is repeated till all the scarce resources are put to the best use which results in optimum combination of the enterprises.

# Lecture 17

## Risk and Uncertainty

Following Frank Knight, the knowledge situation can be classified into the following logical possibilities:



**Perfect knowledge:** There would be no need for farm management experts if knowledge was perfect. If these were so, technology, prices and institutional behaviour would be known with certainty for any period of time in the future. But the concept of perfect knowledge is a fallacious one and does not represent the real world situation.

**Imperfect knowledge:** Imperfect knowledge situation can be classified either as risk or uncertainty. Risk represents less imperfection in knowledge than does uncertainty. Under risk the occurrence of future events can be predicted fairly accurately by specifying the level of probability. When a risk situation prevails, it can be said, for instance, that the chances of a hailstorm at the time of harvesting wheat are 5:95 or 20:80. An *a priori* risk prevails when sufficient advance information is available about the occurrence of an event, e.g. the probability of a head or a tail turning up if an unbiased coin is tossed. Contrary to this, a statistical risk can

only be predicted on the basis of occurrence of several observations in the past. Mortality tables of insurance companies provide good example of statistical risk. An insured vehicle meeting with an accident or an insured house catching fire or being burgled can be assigned probabilities on the past experience of any country. Because of the quantification of imperfect knowledge under a risk situation, the event can be insured.

From the economic point of view, uncertainty is undoubtedly the most important. The occurrence of an event cannot be quantified with the help of probability. Thus future occurrence of an event cannot be predicted. A farmer often finds himself confronted with such a situation where the knowledge is incomplete, yet the decision has to be taken. It becomes, therefore, essential to formulate some estimates however wild, of the most likely outcomes. In practice, however, farmers are unable to draw a clear distinction between risk and uncertainty though the reaction in each situation is markedly different. Mostly the terms risk and uncertainty are used interchangeably.

**Types of Risks and Uncertainties:** They are classified into five categories:

**1. The economic uncertainties** are markedly reduced in many economies where input and product prices are announced before sowing a crop. Economic uncertainties of this nature are usually caused by national and international policies which are beyond the approach of an individual farmer.

**2. Biological uncertainty** is quite common and important in agriculture. Rains or drought, floods, hailstorms, frost, etc., may all affect the yields in agriculture directly or indirectly by increasing the incidence of crop or animal diseases.

**3. Technological uncertainties:** Continuous advancement of knowledge through research activities has made more efficient methods increasingly available for agriculture. Simultaneously, new inventions and innovations may result in an increased efficiency of the existing methods. Thus, improvement of knowledge which is continuous phenomenon may render some techniques less efficient and finally obsolete. Such a change is known as technological progress in agriculture can be found in different methods of cultivation and in fertilizer, irrigation and chemical applications giving different yield responses. Technological

improvement necessarily implies that the same level of input can now produce larger quantities of the produce.

**4. Institutional uncertainties:** Institutions like government, banks, etc., may also cause uncertainties for an individual farmer. Crop cess, credit squeeze, price supports, subsidies, etc. may be enforced or withdrawn without taking an individual farmer into confidence. This type of uncertainty may also result in non-availability of resources in appropriate quantities and at the appropriate time and place.

### **5. Personal uncertainties**

The farm plan may not be executed because of some mishap in the farmer's household or in his permanent labour force.

### **Safeguards against risk and uncertainty**

Some farmers take more risk than others. However, all farmers use one or more measures of different types of safeguard themselves against risks and uncertainties on their farms. The various measures generally used to counter risks and uncertainties in agriculture are as follows:

#### **1. Selection of enterprises with low variability**

There are certain enterprises where the yield and price variabilities are much lower than for others. For example, wheat has relatively much less variability in its yields and prices in irrigated regions than potato. Thus, the inclusion of enterprises with low variability in the farm plans provides a good way to safeguard against risk and uncertainty.

#### **2. Discounting returns**

At this stage we refer to discounting only as a function of risk and uncertainty, and not time. Planning based on single value expectations of input-output coefficients may invariably be misleading as it assumes a perfect knowledge situation. It amounts to deducting a safety margin from the expected prices, yields or incomes.

#### **3. Insurance**

Insurance is another well-accepted method to safeguard against risk and uncertainty. However, insurance in agriculture is not common in many countries including India. It helps the farmer,



whenever used, to lessen the variability in income and minimize the chances of the farm income dropping below a minimum level.

#### **4. Forward contracts**

They reduce the future prices, both of the factors of production and of the products, into certainty. Contracts may either be in money or in kind. Employment of a labourer on the farm for a period of one, two or twelve months on some agreed amount is an example of forward contract in money. Similarly, pre-harvest apple contract in Himachal Pradesh or Jammu and Kashmir is another example. On the other hand, share cropping is a good example of forward contracts in kind. Contracts in kind reduce income variability where contracts in money do extract the opposite.

#### **5. Flexibility**

This refers to the convenience with which the organization of production on a farm can be changed. Some organizations are obviously more flexible than others and flexibility in an organization through change in production helps obtaining advantages and improvements in the economic and technological environment of a farmer. As an uncertainty safeguard, flexibility may be built into farm plan for stabilization of incomes from year to year and to maximize the expected stream of total income over a longer period of time. It differs from diversification in the sense that it aims at preventing the sacrifice of large gains as compared to the prevention of large losses through diversification.

Due to technological and economic changes certain enterprises may suddenly gain or lose importance over time. Thus, quick changes may be required which can only be brought about at a low cost if the plans are not rigid but flexible. Flexibility can be of the following types:

**i) Time flexibility:** Time flexibility may be introduced either through proper selection of products or production methods or partly by both. Orchard plantation is a relatively more rigid enterprise than annual crops like wheat, maize, paddy, etc. A short lived farm structure or equipment is more flexible than one which durable.

**ii) Cost flexibility:** whenever time flexibility is of limited use, cost flexibility becomes important. Cost flexibility refers to variations in output within the structure of a plant with a

longer life. Extension or contraction of output, whenever desired by favourable prices or yields, can be brought about at lower costs for a given plant. through a farmer may find that owning a potato digger on his farm would result in lower costs than those which have to be paid for custom hiring a similar one, yet he may keep on hiring machine in order to have more cost flexibility on his farm.

**iii) Product Flexibility:** product flexibility, like any type of flexibility, aims at changes in production in response to price signals. In this category we consider the form of physical resources, e.g. machines, farm structure, etc., which can be switched readily from one product to another.

### **6. Liquidity and asset management**

It is a form of flexibility but has been put in a distinct class because it represents a different method of management used in case of unpredictable changes on a farm. Liquidity refers to the ease with which the assets on a farm can be converted into cash can also change its form in a relatively short time. If the assets are held in a form which can be easily converted into cash, it provides a safeguard to the farmer by enabling him to make necessary adjustments in response to risk and uncertainties of various types.

### **7. Diversification**

Diversification is a very important, useful and popular method to safeguard against risk and uncertainty in agriculture. Here we refer to diversification as a means of stabilizing incomes rather than profit maximizing related to reaping gains of complementarity and supplementarity.

## **Lecture 18**

### **Linear Programming**

Linear programming (LP) is a budgeting technique that is more refined and systematic than the conventional budgeting in determining the optimum combination of enterprises or inputs so as to maximize the income or minimize the cost within the limits of available resources. It may be defined as *“the analysis of the problems in which a linear function of a number of variables is to be maximized or minimized when those variables are subject to a number of restraints in the form of linear inequalities”*. In linear programming models, the objective of the typical farm i.e., maximization of net profit or cost minimization is achieved through optimal plan generated from its solution. The objective function specified, i.e., profit maximization or cost minimization, is linear in form and constraints on resource restrictions are specified in linear form. LP has been used in agriculture since 1950s. As a normative tool, it provides prudent solutions to farm planning problems.

#### **Components of LP problem**

There are three quantitative components in LP model. They are

- (1) An objective function.
- (2) Resource requirements of alternate activities or processes.
- (3) Resource restrictions (availability).

#### **Assumptions of LP problem**

There are seven basic assumptions:

- (1) Linearity of the objective function
- (2) Divisibility of the activities as well as resources
- (3) Additivity of the resources and activities
- (4) Finiteness of the activities and resource restrictions
- (5) Single value expectations
- (6) Non-negativity of the decision variables and
- (7) Proportionality of activities to resources

- 1. Linearity of the objective function:** All the decision variables in the objective function, i.e., crop and livestock activities are in linear form (without power form) and the objective function is also linear, for example, as  $\pi = 250 X_1 + 350 X_2 + 500 X_3 + \dots + 400 X_n$ . The coefficients of  $X_1$  are the net returns/ prices of the crops and livestock.
- 2. Divisibility of the activities as well as resources:** Continuity of resources and output is implied in this assumption. This means fractional quantities such as 0.2 ha of land and 3.5 qtl of paddy etc., are allowed. But divisibility for livestock activities and labour resources appears to be unrealistic. To get integer values for such livestock activities, an integer programming is being used.
- 3. Additivity of the resources and activities:** It is the reciprocal of divisibility. This assumption implies that the total quantity of a resource used must be equal to the total quantity of resource used by each activity for all resources individually and collectively. This means the activities and resources must be additive in the sense that when two or more activities are followed their total product must be equal to the sum of their individual products and the total resources used equal to the sum of resources used by individual activity. If the resource is used up fully, it should equal the sum of the same resources used by all the activities appearing in the optimal solution.
- 4. Finiteness of the activities and resource restrictions:** With the advent of computers and availability of programmes, a large numbers of activities and constraints are now being specified in the model. But, there should be a limit for such numbers, because infinite number of activities and resource restrictions cannot be accommodated in the model. Hence, this assumption is important in the LP model. In general, it is desired to have more number of the activities than the constraints in LP model.
- 5. Single value expectations:** This assumption connotes certainty assumption and imparts to the LP model, the name of deterministic model. According to this assumption, input-output coefficients ( $a_{ij}$ ), resource availabilities ( $B_j$ ) and prices of activities ( $C_j$ ), all are specified correctly with known quantities in the model and they all relate to a particular period of time. In the risk programming models this assumption is relaxed.
- 6. Non-negativity of the decision variables:** All the crops and livestock activities should have positive values in their magnitude. Negative values for such decision variables cannot make any sense. Hence, this assumption is imperative.

- 7. Proportionality of activities to resources:** According to this assumption, linear relationship is held between activities and resources. This means that resource requirement to produce one unit of crop or livestock activity varies directly with the level of output of crops and livestock.

### **Basic Concepts in LP**

- 1. Goals of the Programming Model:** Programming model guides the farmers to specify the farm plans which will give him maximum income under the given constraints, prices, yields and resource requirements. Cost minimization in the cattle feeding problems, poultry feeding problems and transportation models, is considered in the objective function of LP model.
- 2. Activity or Process:** The word activity is used to refer to crop and livestock enterprises being undertaken. A typical method of production with specific resources requirement in crops and livestock is referred to as a process or activity. Based on this concept, crops or livestock activities are delineated into separate or individual activities in the model. For example, local paddy crop requiring different levels of inputs for obtaining various output levels are treated as separate activities. Similarly, if two cows of the same breed are reared on different rations, they can be taken as separate activities in the model. A process is a method of converting a resource into a product with specified input-output relationship. This is also often referred to as technical coefficient.
- 3. Types of activities:** These are: (i) real activities, (ii) intermediate activities, (iii) purchasing, (iv) selling and (v) borrowing activities.
  1. Paddy, sugarcane, poultry eggs, milch cattle, etc., are real activities because they are produced on the farm for sale in the market. Real activities are also called decision variables, which are specified, in the object function on the LP problem. The optimal solution indicates the magnitudes of real activities and hence they are called decision variables.
  2. Fodder, though produced on the farm and if not sold in the market, it cannot become real activity, so it is intermediate activity.
  3. Purchasing activities means the inputs like fertilizers and pesticides, which are purchased from the market and used in the production process.
  4. Selling activities represent the sale of products produced on the farm.

5. To supplement owned funds, depending on the need, borrowing activity is included in the LP model
6. Prices for products and resources are to be ascertained with certainty. Too high or too low prices will distort the income estimates and thereby profit, often leading to results of unrealistic magnitude. In general, the average prices, pooled over three to five years are considered for LP model.
4. **Restrictions:** These are also called limitations or constraints. Land, labour and capital are generally considered as restraints. In the development of models for obtaining realistic results, sometimes 150 to 200 restraints are also considered by researchers in economic studies. In general, macro level studies will have more constraints than micro level studies, because of the complexities involved in macro level situation. At micro level the farmers may have restrictions regarding number of livestock animals, crop acreages, etc. Amount of labour availability during peak season of the crop growth is generally considered as the most common restriction seen in the LP model. Likewise, a farmer may have access to limited quantities of many resources. The availability and requirements in respect of machine labour, bullock labour, hired human labour, family labour, skilled labour, unskilled labour, etc., in different time periods, i.e., a week, a month, a season and a year may be considered in the programming model as separate restrictions or constraints. All these restrictions can be specified in the model in three types, i.e., greater than equal to constraints or less than equal to constraints, or equal to or equality constraints.
5. **Feasible Solution:** Any solution to a linear programming problem is said to be feasible if none of the  $x_{js}$  is negative. Thus, it is a solution in which the values of the variables (ordinary and slack) satisfy both the constraints and the non-negativity restrictions. Such a solution can only be found in the first quadrant. There is no guarantee that all linear programming problems will have feasible solutions.
6. **Unfeasible Solution:** It refers to a solution wherein some of the variables,  $x_{js}$ , appear at a negative level. Obviously, therefore, a solution to a linear programming problem does not satisfy the non-negativity restrictions.

7. **Basic Solution:** The values of the variables in which the number of non-zero-valued variables is equal to the number of constraints is called basic solution. Of the basic solutions to a problem, there will be an optimal solution that satisfies the above criterion.
8. **Optimum Solution:** Unless alternate optima for a linear programming problem occur, one of the feasible solutions is optimum, provided a feasible solution exists. Such a feasible solution which also optimises the objective function is called an optimum solution. The set of  $x_{js}$  in this case satisfies the set of constraints and non-negativity restrictions and also maximizes the objective function.
9. **Unbounded Solution:** Many a time, faulty formulation of a linear programming problem may result in a arbitrarily large value of the objective function and the problem has no finite maximum value of  $\pi$ . It may require only one or more variables to assume arbitrary large magnitudes. This represents a case of an unbounded solution to a linear programming problem.

Algebraically it is stated as

$$\text{Maximize } \pi = C' X$$

Subject to

$$AX \leq B$$

$\geq$

$$X \geq 0$$

where  $A$  is  $m \times n$  matrix of technical coefficients

$C$  is  $n \times 1$  vector of prices or other weights for the objective function

$X$  is  $n \times 1$  vector of activities (crops and livestock to be produced which are unknown decision variables)

$B$  is  $m \times 1$  vector of resource or other constraints, availabilities in physical units, such as labour, land, etc., and the objective function.