

Study Material
(Farm Management)
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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 20th 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
$$Y=f (X_1, X_2 / X_3.....X_n)$$
 where Y is output, X_1, X_2 are variable inputs and $X_3.....X_n$ are fixed inputs.
6. Long run production period: The planning period during which all the resources can be varied. It is written as
$$Y=f (X_1, X_2 ,.....X_n)$$
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 resource 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 resource.
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.

$$y = b_0 + b_1 x + b_2 x^2 \quad \text{where } b_0, b_1, \text{ \& } b_2, \text{ are the parameters. Such PFs are quite common in}$$

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.

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

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.

Fertilizer (X) (in kg)	Total Product (Y) (in kg)	Marginal Product (Returns) ($\Delta Y/\Delta X$)
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

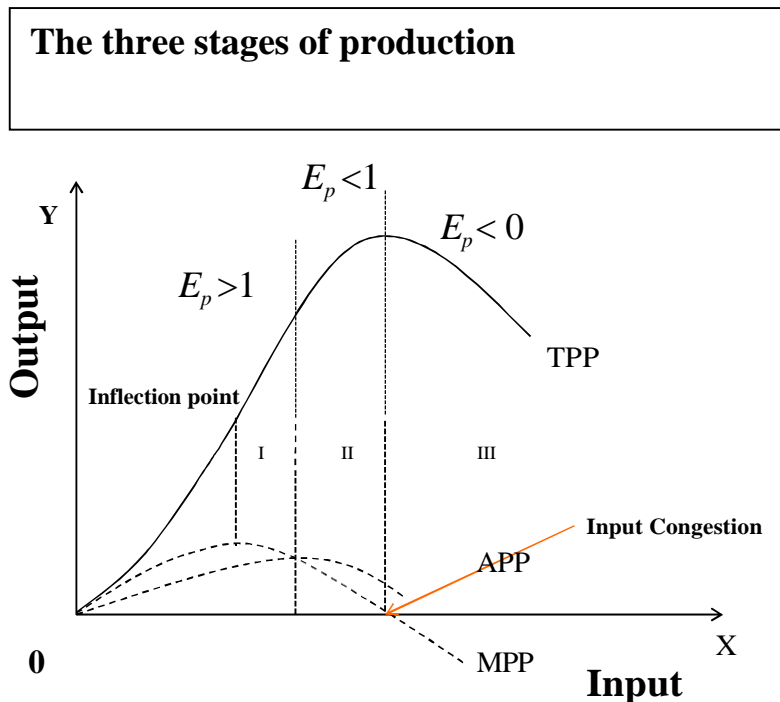
Factor-Product Relationship

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

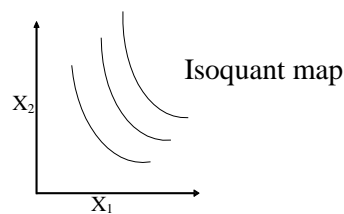
Factor – Factor Relationship

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,

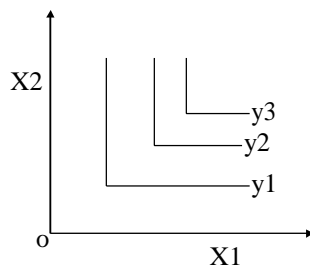
2. Isoquants to right indicate higher output level,
3. Isoquants do not intersect each other,
4. Isoquants are convex to origin showing diminishing MRTS.

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.

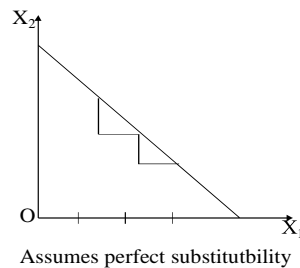


Substitutes: Two resources are said to be substitutes when change in price of one leads to a change in demand for another (MRTS is $-ve$).

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

$\frac{X_2}{\text{Female labour}}$	$\frac{X_1}{\text{Male labour}}$	ΔX_2	ΔX_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

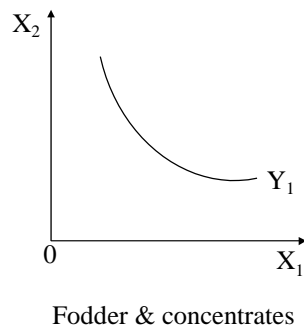
e.g. Two labourers. Decision rule use either of the two depending on the relative prices.

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)

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

X_1	X_2	ΔX_2	ΔX_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



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

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

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.

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

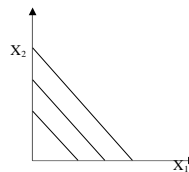
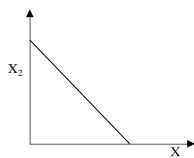
$$dy = \frac{Dy}{DX_1} dx_1 + \frac{Dy}{DX_2} dx_2$$

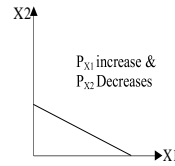
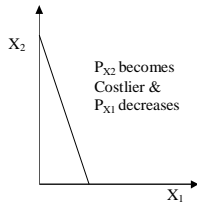
dy = 0 on an isoquant

$$-\frac{dx_2}{dx_1} = \frac{Dy/DX_1}{Dy/DX_2} = \frac{MP_1}{MP_2}$$

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:**

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

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

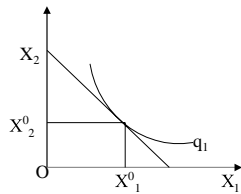
$$PX_1 (\Delta X_1) = PX_2 (\Delta X_2)$$

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

If $P_{X_1} (\Delta X_1) < P_{X_2} (\Delta X_2) \rightarrow$ Increase X_1

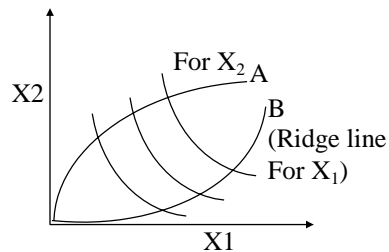
(3) Graphic Method:

Slope of isoquant = slope of iso-cost line



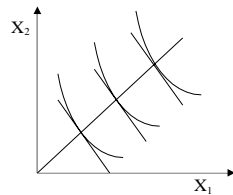
Iso-cline: A line or curve connecting the least cost combinations of inputs for all output levels is known as isocline. Isocline passes through all isoquants at points where they have same slope. It shows how the relative proportion of the factors changes as the output is increased. It shows that resources 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 isoquants 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 isoquants 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 isoquant 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

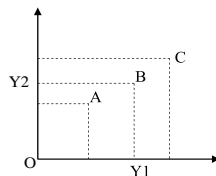
Product-Product Relationship

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?

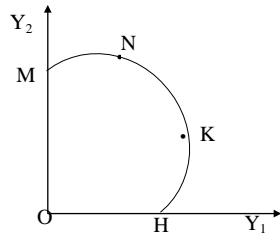
Algebraically, $y_1 = f(y_2)$

Basic Relationship: The basic product-product relationships are

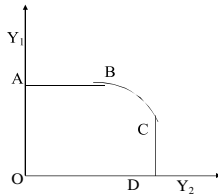
- (i) **Joint Products:** Joint products result from the same production process and the production of one without the other is not possible. For instance, cotton lint & seed, wheat & straw. In such cases the quantity of one product produced decides the quantity of other product. For production decisions, 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.

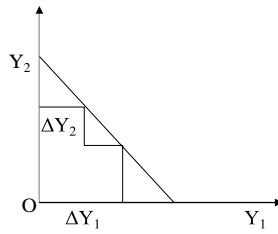


- (iii) Supplementary products: Exists when increase or decrease in one product does not affect the production level of the other product. All supplementary relationships should be taken advantage of by producing both products to the point where the products become competitive.



- (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.

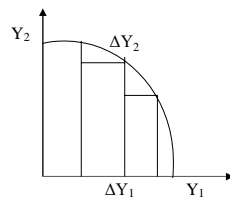


$\frac{\Delta y_1}{\Delta y_2} = \frac{\Delta y_{12}}{\Delta y_{22}} = \dots = \frac{\Delta y_{1N}}{\Delta y_{2N}}$. This is normally a short run relationship. When this relationship

exists it will be economical to produce only one of the products depending upon the relative prices.

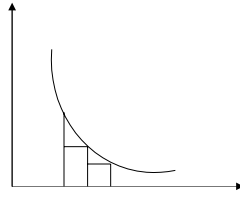
(b) Increasing Rate of Substitution: In this each unit increase in the level of one product is accompanied by larger and larger decrease in the level of other product.
e.g. wheat & gram will substitute at increasing rate for capital and labour.

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



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

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 profitableness (**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.

Sr. No.	Agricultural Production Economics	Farm Management
1	It is a science in which the principles of choice are applied to use of land, capital, 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 9

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.

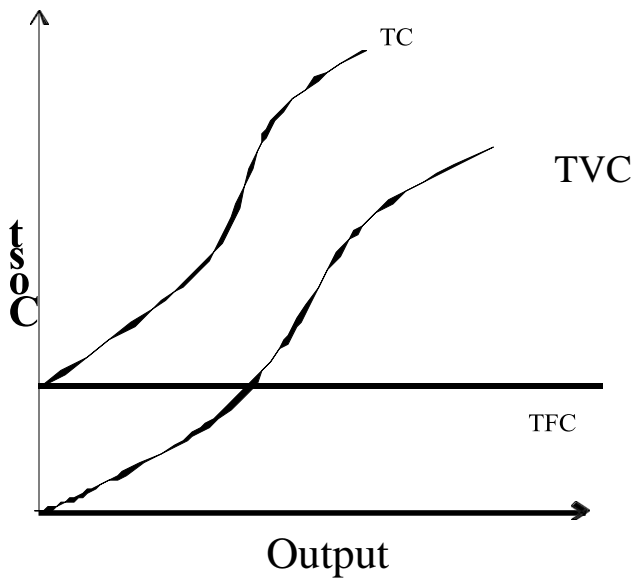
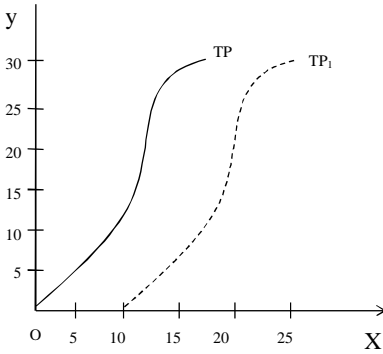
Total costs = FC+VC

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.



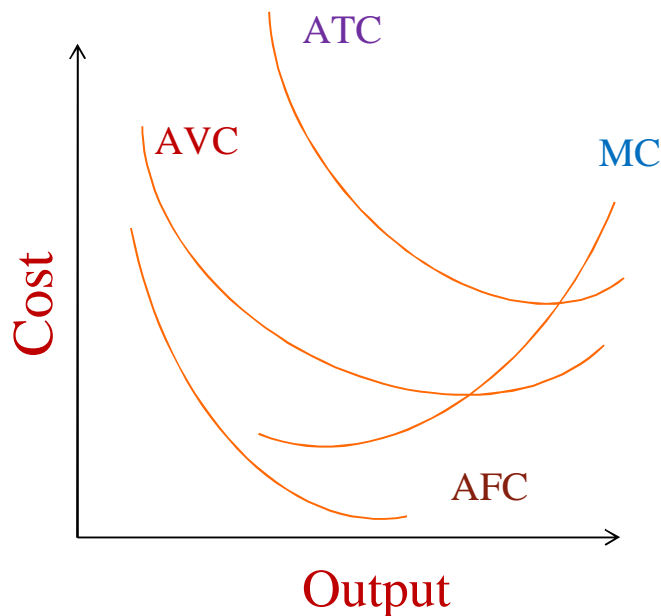
1. Total fixed cost (TFC): The costs incurred on all fixed inputs used in production are known as TFC. These do not change with the output levels & hence represented by a straight line parallel to X axis.
2. Total variable cost (TVC): Refers to the costs of variable input used in production & is computed 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 10 & 11

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 st	1000	Poultry	1500
2 nd	1000	Dairy	1400
3 rd	1000	Crops	1300
4 th	1000	Crops	1300
5 th	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.

1st year – 100+10 =110; 2nd – 110@10% = 110+11=121; 3rd year- 121@10@ = 121+12.10 = 133.10 4th: 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 12

Types of Farming

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

Farming

Types

- 1. Diversified including marginal**
- 2. Specialised**
- 3. Mixed**
- 4. Ranching**
- 5. Dry**

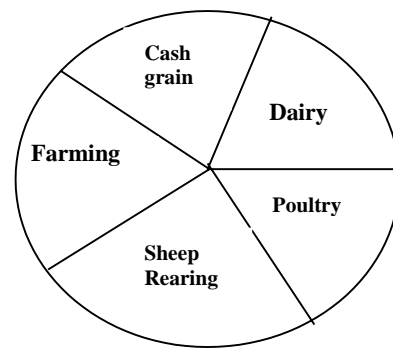
A. Types of farming

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..

Lectures 13 & 14

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 (₹)	
A	Variable cost						
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	
10	Total variable cost(A=8+9)			8767.46		109593.3	
B	Fixed cost						
i)	Rental value of land			5000		62500	
ii)	Interest on fixed capital			648		8100	
iii)	Depreciation			810		10125	
	Total fixed cost			6458		80725	
C	Total cost (A+B)			15225.46		190318.3	
D	Production and Returns						
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	
5	Gross Returns			25180		314750	
6	Net Returns (₹)			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.

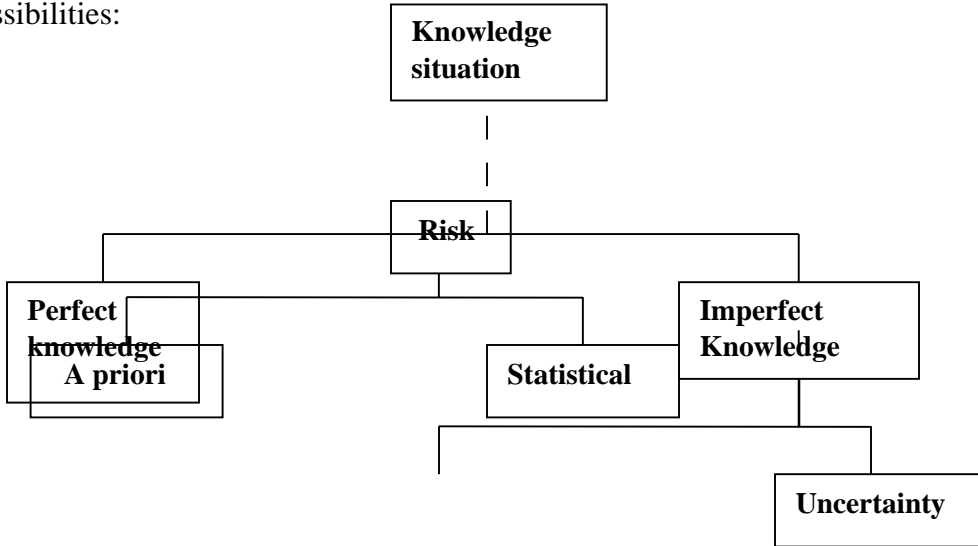
6. Identification of risks: List out all types of risks viz., production risk, weather risk, technological risk, institutional risk, marketing risk, etc., faced by the farmers. Particularly the incidence of pests, rodents and diseases, frequency of drought occurrence over time, cyclones, floods and their 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 identifying 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 15

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 16

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_i 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.

Lecture-17

Natural Resource Economics

Natural Resources

Our environment provides us with a variety of goods and services necessary for our day to day lives. Nature gives us with the basic needs for our survival such as food, shelter, clothes, etc. We use air, water, soil, minerals, coal, petroleum, animals, plants etc. in our daily life? But do you ever think how long these precious materials of nature will last? The growing population, rapid industrialisation and–urbanisation have created heavy demand on natural resources.

The term “natural resource” means anything that we use from our environment to achieve our objective. For example, we require bricks, cement, iron, wood etc. to construct a building. All these items are called resources for construction of building.

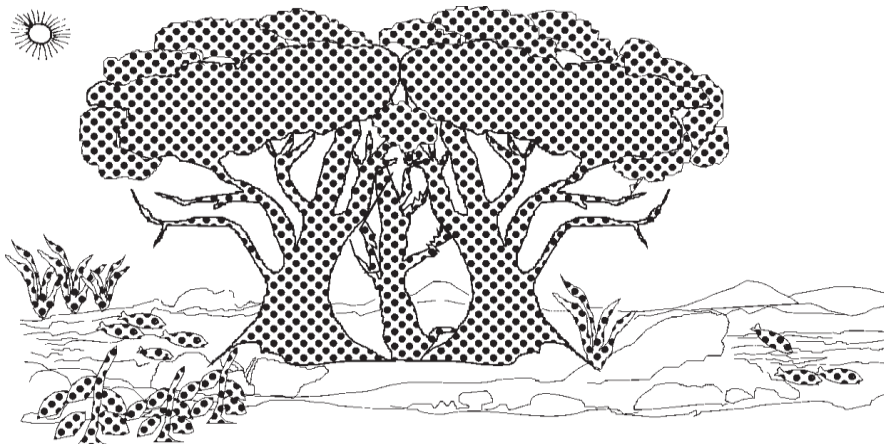
A resource can be defined as ‘any natural or artificial substance, energy or organism, which is used by human being for its welfare.

These resources can be two types:

- (a) Natural resources
- (b) Artificial resources.

All that nature has provided such as soil, air, water, minerals, coal, sunshine (sunlight), animals and plants, etc., are known as natural resources. The resources, which have been developed by human beings during the growth of civilization, are called artificial resources. For example, biogas, thermal electricity, plastics. These man-made resources are generally derived from some other natural resources. For example, plastics from the natural resource, petroleum.

The natural resources include, air, water, soil, minerals, along with the climate and solar energy, which form the non-living or ‘abiotic’ part of nature. Interactions between the abiotic aspects of nature and specific living organisms together form ecosystems of various types. Many of these living organisms are used as our food resources. Others are linked to our food less directly, such as pollinators and dispersers of plants, soil animals like worms, which recycle nutrients for plant growth, and fungi and termites that break up dead plant material so that micro-organisms can act on the detritus to reform soil nutrients.



Classification of Natural Resources



(i) Classification based on source of origin: Abiotic vs. Biotic

- BIOTIC RESOURCES are resources which come from biosphere and have a life example. human beings, flora and fauna, fisheries, livestock etc. The materials obtained from them are also considered biotic, example fossil fuels, coal, petroleum, because these are formed from decayed organic matter.

- ABIOTIC RESOURCES are those resources which come from non-living, non-organic material. Example, rocks, minerals, air, water, metals etc.

(ii) Classification based on exhaustibility: Renewable vs. Non-renewable

- PERPETUAL RESOURCES – these are resources which exist irrespective of the amount of their usage. With adequate technology, they provide a vast potential for use. Example. Sun, wind and water

- RENEWABLE RESOURCES - the resources which can be renewed and reproduced by physical, chemical or mechanical processes are known as renewable or replenishable resources. These resources are able to increase their abundance through reproduction and utilization of simple substances. Examples of such resources are water, forests and wildlife, plants etc. we can further divide into continuous or flow and biological.

Renewable Resources can be further classified as Living Renewable Resources and Non-Living Renewable Resources: Some examples of renewable resources though they do not have life cycle but can be recycled are wood and wood-products, pulp products, natural rubber, fibers (e.g. cotton, jute, animal wool, silk and synthetic fibers) and leather.

- Living Renewable (biological) resources are those renewable resources which come from living (biotic) sources – like forests, plants
 - Non-Living Renewable resources are those that renewable resources which come from non-living (abiotic) sources like land, water, air. Example, metals, minerals, wind, sun etc.
 - Continuous/ Flow Renewable resources are resources which do not need regeneration. Similar to that of perpetual resources, example wind, tides etc.
- NON-RENEWABLE RESOURCES - this process takes place over a long geological time. Examples of such resources are minerals and fossil fuels. This may take millions of years in their formation. Some of the resources like metals are recyclable and some like fossils fuels cannot be recycled and as such they get exhausted with their use.

Non-Renewable Resources can be further classified as Recyclable and Non-Recyclable resources.

- Recyclable resources are those which can be processed to be used again and again. These are non-renewable resources, which can be collected after they are used and can be recycled. These are mainly the non-energy mineral resources, which occur in the earth's crust (e.g. ores of aluminium, copper, mercury etc.) and deposits of fertilizer nutrients (e.g. phosphate rock and potassium and minerals used in their natural state like asbestos, clay, mica etc)
- Non- Recyclable resources are those which once used perish, example coal. These are non-renewable resources, which cannot be recycled in any way. Examples of these are fossil fuels and uranium, which provide 90 per cent of our energy requirements.

There are a few substances too which can be recycled a few times, before they completely perish or turn non-renewable resources.

(iii) Classification based on ownership: Individual vs. Community vs. National vs. International

- This classification is inspired from socio-economic demarcation or classification of resources and natural wealth. Interestingly, the resources (metals/ minerals) found on these pieces of land ownership also belong to the concerned owner.

- INDIVIDUAL RESOURCES - these are resources owned by individuals privately. Example, land owned by a farmer allotted to them by government against the payment of revenue. Urban people own plots, houses and other property. Some other examples include plantation, pasture lands, ponds, water in wells etc.

- COMMUNITY RESOURCES- these include resources that are accessible to all the members of the community like the village grazing grounds, burial grounds, village ponds, public parks, picnic spots, playgrounds in urban areas are accessible to all the people living there.

- NATIONAL RESOURCES- technically speaking all the resources belong to the nation because the country has legal powers to acquire even private property for public good. This we may have seen many times when government take fields owned by private individuals to construct roads, canals, railways. All minerals, water resources, forests, wildlife, land within the political boundaries and oceanic area upto 12 nautical miles from the coast termed as territorial water and resources therein belong to the nation.

- INTERNATIONAL RESOURCES - there are also international resources regulating resources. The oceanic resources beyond 200km of the Exclusive Economic Zone belong to open ocean and no individual country can utilize these without the consensus of international institutions.

(iv) Classification based on the stage of development of the resource: Potential vs. Developed vs. Stock Reserves

- POTENTIAL RESOURCES are those which can be found in a particular region but are yet to be put to use. Example. Regions in states like Rajasthan and Gujarat have huge potential for development of solar, wind and tidal energy, which is yet to be used.

- DEVELOPED/ACTUAL RESOURCES includes are resources which have been/ are surveyed and their quality and quantity have been determined for utilization. The development of resources however depends on technology and level of their feasibility

- STOCK - the materials in the environment which have the potential to satisfy human needs but human beings do not have the appropriate technology to access these, are included among stock. Water for example is a compound of two inflammable gases; hydrogen and oxygen which can be used as a source of energy. But we do not know how to use them for this purpose. Therefore it is considered as stock.

- RESERVES - they are the subset of stock/ actual which are/ can be used with the help of existing technical knowledge. Reserves can be used for meeting future requirements. For example water in lakes, dams, forests etc is a reserve which can be used in the future.

(v) Classification based on distribution: Ubiquitous vs Localized

-UBIQUITOUS RESOURCES are found everywhere (e.g., air, light, water).

-LOCALIZED RESOURCES are found only in certain parts of the world (e.g., copper and iron ore, geothermal power).

Natural resource economies – definition, subject matter and scope

Natural resource economics deals with the supply, demand and allocation of the earth natural resource. Main objective of natural resource economics is to better understand the role of natural resources in the economy in order to develop more sustainable methods of managing those resources to ensure their availability to future generations. Resource economists study interactions between economic and natural systems, with the goal of developing a sustainable and efficient economy. It is a multi-disciplinary field of academic research.

Natural resource management

Natural resource management refers to the management of natural resource such as land, water, soil, plants and animals with a particular focus on how management affects the quality of life for both present and future generations. Natural resource management deals brings together land use planning, water management, biodiversity conservation and the future sustainability of industries like agriculture, mining, fishing, etc.

Environmental and Ecological Economics

The insights into sustainability provided by mainstream economics are taken much further by environmental and ecological economists. The main areas of contribution include the following:

- A classification of sustainability views according to assumptions about the conservation of natural resources
- Extending the analysis of externalities to provide a basis for designing anti- pollution policies and deciding on the resources it is desirable to devote to avoiding pollution
- A range of methodologies for evaluating the services provided by environmental assets and social capital to extend the inclusiveness of Cost-Benefit Analysis.
- Models for projecting the pricing and depletion of finite resources.
- Assessments of the implications of various access regimes governing the harvesting of renewable resources

There is considerable overlap in the subject matter of ecological and environmental economics. The key difference is one of orientation. Environmental economics tends to embrace the Neo-classical paradigm as an analysis of the economic system and seeks to incorporate environmental assets and services. Ecological economics gives priority to the health of complex interrelated ecological systems and consider how economic behaviour can be modified to that end.

Environment-Economy Interaction

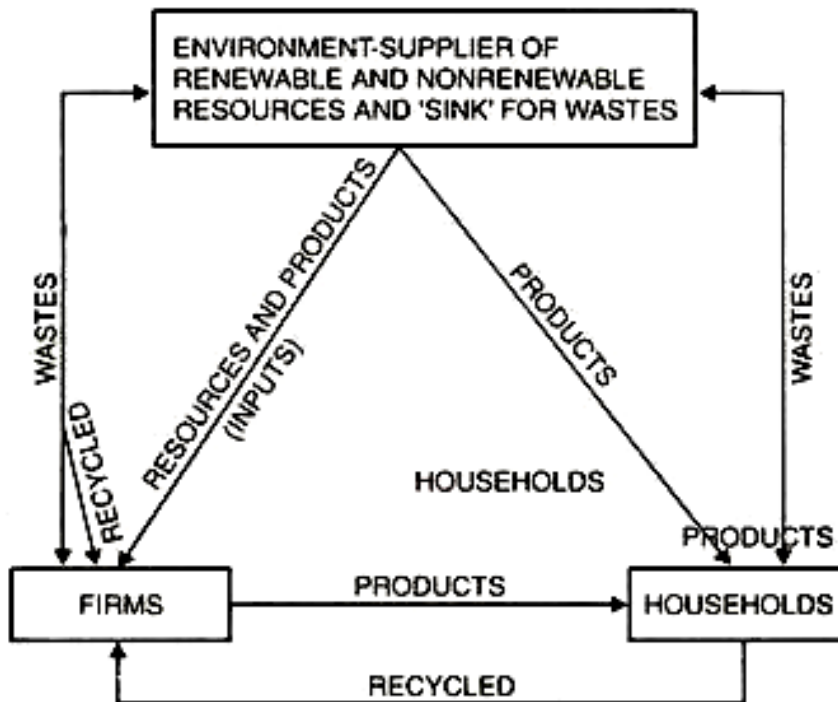
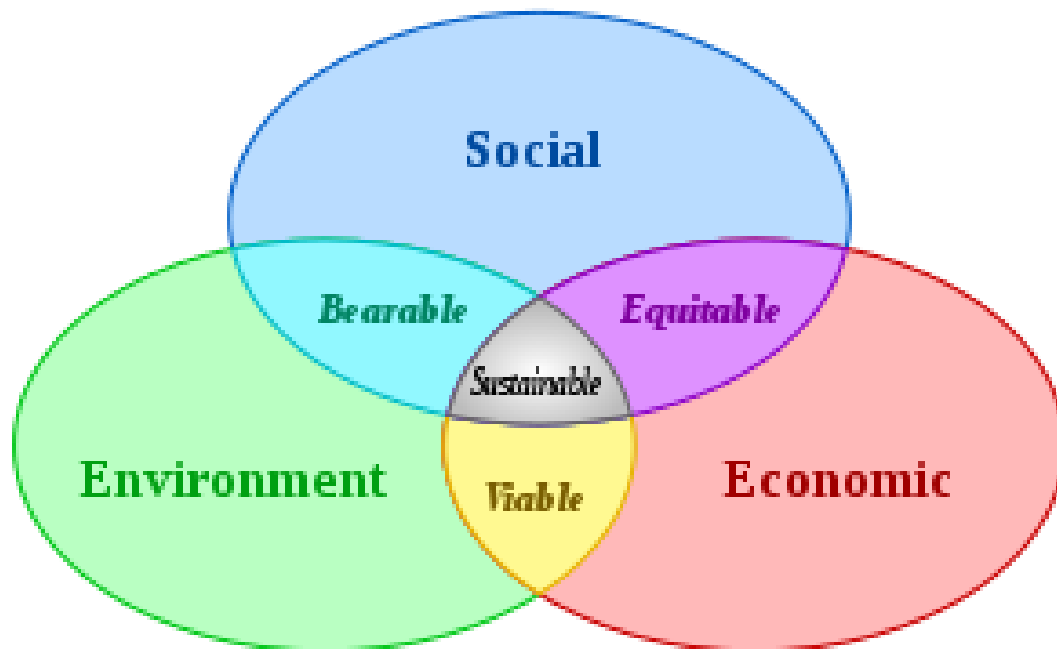
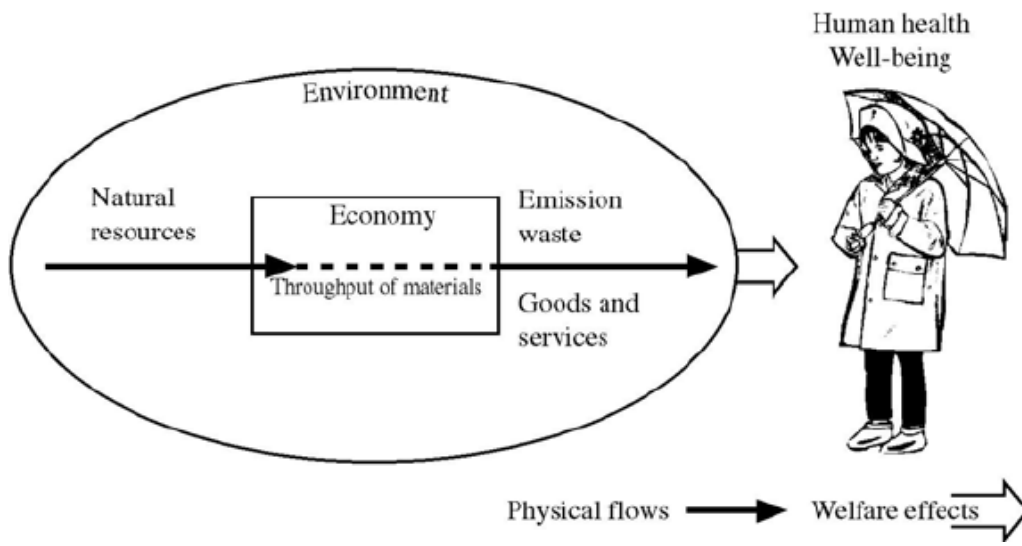


Fig. 2. A Material Balance model of the Economy—Environment Interaction.



How does NRE help in agriculture?

Resource economists provide science-based information to help agriculture producers balance production demands with elements central to agricultural sustainability, including:

- Maintenance and improvement of air and soil quality
- Adaptation and management of climate change dynamics
- Efficient use of surface and groundwater supplies
- Maintenance of landscape vistas, wild plant and animal habitats, and recreational areas

Difference between NRE and Agricultural Economics

Natural Resource Economics	Agricultural Economics
<p>Natural resource economics is a transdisciplinary field of academic research within economics that aims to address the connections and interdependence between human economies and natural ecosystems.</p>	<p>Agricultural economics is an applied field of economics concerned with the application of economic theory in optimizing the production and distribution of food and fiber.</p>
<p>Its focus is how to operate an economy within the ecological constraints of earth's natural resources.</p>	<p>It focuses on maximizing the crop yield while maintaining a good soil ecosystem.</p>
<p>We study how the environment and natural resources can be managed to provide the greatest net benefits.</p>	<p>We study the interactions between farming and the environment.</p>
<p>Our research covers terrestrial and marine biodiversity conservation, pollution, bio-economic modelling of invasive pests, bushfire management, adoption of new conservation practices by landholders and more.</p>	<p>Our research covers climate change impacts on agriculture, land degradation, carbon storage on farms, perennial farming systems, salinity management and more.</p>
<p>Resource economics brings together and connects different disciplines within the natural and social sciences connected to broad areas of earth science, human economics, and natural ecosystems</p>	<p>Agricultural economics today includes a variety of applied areas, having considerable overlap with conventional economics with substantial contributions to research in economics, econometrics, development economics, and environmental economics. Agricultural economics influences food policy, agricultural policy, and environmental policy.</p>

Unique Properties/Characteristics of Natural Resources

Resources have three main characteristics namely:

- 1) Utility,
- 2) Limited availability,
- 3) Potential for depletion or consumption.

In economics, **utility** is a measure of satisfaction, referring to the total satisfaction received by a consumer from consuming a good or service.

Scarcity: Scarcity is the fundamental economic problem of having humans who have unlimited wants and needs in a world of limited resources. It states that society has insufficient productive resources to fulfil all human wants and needs.

Resource depletion: Resource depletion is an economic term referring to the exhaustion of raw materials within a region. Resource depletion is most commonly used in reference to farming, fishing, mining, and fossil fuels.

Causes of Resource Depletion

- Over-consumption/excessive or unnecessary use of resources
- Non-equitable distribution of resources
- Overpopulation
- Slash and burn agricultural practices, currently occurring in many developing countries
- Technological and industrial development
- Erosion
- Irrigation
- Mining for oil and minerals
- Aquifer depletion
- Forestry
- Pollution or contamination of resources

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Natural Resource Economics

Externalities

What Is an externality?

An externality is an economic term referring to a cost or benefit incurred or received by a third party. However, the third party has no control over the creation of that cost or benefit.

An externality can be either positive or negative and can stem from either the production or consumption of a good or service. The costs and benefits can be both private—to an individual or an organization—or social, meaning it can affect society as a whole.

Pollution emitted by a factory that muddies the surrounding environment and affects the health of nearby residents is a negative externality. The effect of a well-educated labour force on the productivity of a company is an example of a positive externality.

Externalities in Agriculture

Positive Externalities	Negative Externalities
<i>Cultural</i>	
<ol style="list-style-type: none"> 1. The landscape itself (good/goods) 2. Enhanced cultural landscape, geographical identity 3. Sense of place, heritage, leisure, recreational and tourism 	<ol style="list-style-type: none"> 1. Impoverished landscape 2. Damaged geographical identity 3. Devastated heritage
<i>Environmental</i>	
<ol style="list-style-type: none"> 1. Viable ecosystems 2. Biodiversity and its preservation 3. Water quality and water availability 4. Soil quality, air quality 5. Climate stability 6. Resilience to fire, resilience to flooding 	<ol style="list-style-type: none"> 1. Damage for populations of flora and fauna 2. Damaged soil, biodiversity loss, soil erosion 3. Water, air pollution, gas emissions 4. Destruction of protected objects of nature 5. Polluted environment from different chemical nutrients, 6. fertilizes
<i>Social</i>	

<ol style="list-style-type: none"> 1. Maintenance of rural viability and other 2. Employment of rural inhabitants 3. Food security and safety 4. Stable income, cultural heritage 	<ol style="list-style-type: none"> 1. Destruction of cultural objects 2. Food insecurity
<i>Others</i>	
<ol style="list-style-type: none"> 1. Welfare of inhabitants, livestock welfare 	<ol style="list-style-type: none"> 1. Human health problems caused by agricultural activity, 2. Noise

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Natural Resource Economics

Goods in Economics

In economics, goods can be categorized in many different ways. One of the most common distinctions is based on two characteristics: excludability and rivalrousness. That means we categorize goods depending on whether people can be prevented from consuming them (excludability) and whether individuals can consume them without affecting their availability to other individuals (rivalrousness).

Based on those two criteria, we can classify all physical products into four different types of goods: private goods, public goods, common resources/ common property resources and club goods. We will look at each of them in more detail below

Private Goods

Private Goods are products that are excludable and rival. They have to be purchased before they can be consumed. Thus, anyone who cannot afford private goods is excluded from their consumption. Likewise, the consumption of private goods by an individual prevents other individuals from consuming the same goods. Therefore, private goods are also considered rival goods. Examples of private goods include ice cream, cheese, houses, cars, etc.

Public Goods

Public goods describe products that are non-excludable and non-rival. That means, no one can be prevented from consuming them, and they can be used by individuals without reducing their availability to other individuals. Examples of public goods include fresh air, knowledge, national defence, street lighting, etc.

Common Resources/Common Property Resources

Common resources are defined as products or resources that are non-excludable but rival. That means they can be used by virtually anyone. However, if one individual consumes common resources, their availability to other individuals is reduced. The combination of those two characteristics often results in an overuse of common resources (see also the tragedy of the commons). Examples of common resources include freshwater, fish, timber, pasture, etc.

Club Goods/Low Congestion/Toll Goods

Club goods are products that are excludable but non-rival. Thus, individuals can be prevented from consuming them, but their consumption does not reduce their availability to other individuals (at least until a point of overuse or congestion is reached). Club goods are sometimes also referred to as artificially scarce resources. They are often provided by natural monopolies. Examples of club goods include cable television, cinemas, wireless internet, toll roads, etc.

In a Nutshell

There are four different types of goods in economics which can be classified based on excludability and rivalrousness: private goods, public goods, common resources, and club goods. Private Goods are products that are excludable and rival. Public goods describe products that are non-excludable and non-rival. Common resources are defined as products or resources that are non-excludable but rival. And last but not least, club goods are products that are excludable but non-rival.

	Excludable	Nonexcludable
Rival	<p>Private Goods</p> <ul style="list-style-type: none"> Food and clothing Car House 	<p>Commons Goods</p> <ul style="list-style-type: none"> Fish in open sea Atmosphere Public waterways
Nonrival	<p>Low-congestion Goods</p> <ul style="list-style-type: none"> Cable television Satellite radio Online WSJ 	<p>Public Goods</p> <ul style="list-style-type: none"> Tax-based: <ul style="list-style-type: none"> Nuclear umbrella The law Indirect private funding: <ul style="list-style-type: none"> Search engine On the air TV

Importance

of Common property Resources

Within the field of economics, common resources are generally referred to as common pool resources, common property resources, or common access resources—a type of good whose characteristics or size make them costly or difficult to regulate and exclude potential users from obtaining benefits from their use. Common pool resources typically contain a core resource (e.g., timber in a forest) from which a limited quantity of units can be extracted when the natural systems replenishing this resource are properly maintained and the resource is not degraded.

Unlike pure public goods, common pool resources face problems of congestion or overuse, because they are subtractable. A common-pool resource typically consists of a core resource (e.g. water or fish), which defines the stock variable, while providing a limited quantity of extractable fringe units, which defines the flow variable. While the core resource is to be protected or nurtured in order to allow for its continuous exploitation, the fringe units can be harvested or consumed.

Types of Common Property Resources

We can list a large number of CPRs, which can be brought under the broad headings like land resources, forest resources, water resources, and fishery resources. These resources are being degraded overtime due to overuse or lack of proper management.

Land Resources

Common property land resource refers to lands identified with a specific type of property rights. The common lands covered in the National Sample Survey (NSS) enquiry are panchayat lands, government revenue lands, village common lands, village thrashing lands, unclassified forest lands, woodlands and wastelands, river banks, and lands belonging to other households used as commons.

Forest Resources

Another category of land for which common property rights may exist is land under forests. Unclassified forests, with very low productivity, are always open to use by local communities: Accordingly, both protected and unclassified forests are treated as forming a part of common property forest resources. It is, therefore, the subset of total forest area minus reserve forests to which common property rights are assumed to exist.

Water Resources

There are a variety of resources of water, which are in the public domain, and a significant part of these are included in the category of commons. Examples are flows of rivers, tanks and natural lakes, groundwater, wetland and mangrove areas, and such other water bodies. Man-made water resources such as dams and canals, tube wells, other wells, and supply of all types of potable water also fall in the category of CPRs depending upon their property rights. Unfortunately, even after many debates about property rights (such as traditional rights, community rights, and basic need human rights), water has not yet been declared as CPR in India, though references are made in the water policy document indirectly.

By and large, water resources in India are in common property regimes only. Irrigation canals are managed jointly by the government and communities. Traditionally, tanks, village ponds, and lakes - all of which are treated as CPRs-are sources of water for drinking, livestock rearing, washing, fishing and bathing, and several sanitary-related activities.

Issues in economics and management of Common Property Resources

There is growing awareness of the significance of Common Property Resources (CPRs) in the rural areas. In past, these resources were neglected by policy makers and planners. The increasing population pressure, institutional changes, privatisation, commercialization, mechanization have played important role in the deterioration of these resources.

Broadly the problems associated with CPRs are:

- (i) Definition,
- (ii) Accountability,
- (iii) Depletion
- (iv) Shrinkage, and
- (v) Policy and management.

A common property resource is potentially subject to congestion, depletion or degradation when its use is pushed beyond the limit of sustainable yield. Hardin (1968) called the problem of CPR as the 'tragedy of the commons'.

He brought out the problem by illustrating it through the metaphor of shepherds and the size of their herds. It is in the self-interest of individual shepherds that they increase the size of their herds, as it will generate more profits. Eventually the overall sheep population will exceed the pasture's (the common's) regeneration capacity. As a result, the pasture area will shrink and degenerate. While Hardin explained the problem through a lucid example, it holds true for all natural resources which do not have well-defined property rights.

There are three variables involved: i) the quantity of the resource (let us call it C for commons), ii) the rate of replenishment of the resource (Rr), and iii) the rate of use of the resource (RU). Whenever RU exceeds Rr we have a tragedy. If C is too large and Rr is too small the depletion of the resource is so slow that it is not noticed and it is not viewed as a tragedy.

However, with the passage of time as population size increases, there is an increase in Rr, and the depletion is perceptible.

The tragedy of the commons can be represented by the formal framework of the 'prisoner's dilemma' (PD) game. This game has a peculiar characteristic, which makes it an excellent representation of an important class of social phenomena. It brings out that the problem of social aggregation is not so simple.

There are situations when everyone may suffer loss even if every individual acts rationally. Let us consider the case of two herdsman who must decide on the number of animals to let pasture on a common land (belonging to both).

To further simplify the presentation, let us assume that the choice facing each herdsman is between letting one or two animals on the common land. If both herdsman choose to have one animal each, each of them gains Rs. 5.

If, however, both choose to have two animals each on the common land, these animals will be underfed and will lose much of their economic value. As a result, the total gain each herdsman may expect for having two animals pasturing is Rs. 4. Finally, if one herdsman has only one animal on the common land, and the other has two, their gains are Rs. 3 and Rs. 6 respectively. This situation can be summarised by entering the different gains, called payoffs, in a double entry matrix, as shown in Table 11.1, where the first number in each cell is the payoff accruing to herdsman 1, while the second number refers to herdsman 2.

Table 11.1: Pay-off Matrix for the Herdsmen

		Herdsman 1	
		No. of animals	
Herdsman 2	1	5, 5	6, 3
	2	3, 6	4, 4

It is easy to see that each herdsman will choose the strategy 'put two animals'. Such a strategy is called a dominant strategy (maximising own benefit), since the optimal action for one player does not depend on the strategy followed by the other player.

Here each player has a dominant strategy so that the Nash equilibrium of the game comes out naturally as the one where each player chooses to put two animals on the common land. Here lies the tragedy of the commons: even though it would be better for both herdsmen to put only one animal on the commons (Pareto-superior outcome), it is individually rational for each of them to put two animals, and the Pareto-inferior outcome obtains.

Here 'the rational individual cannot obtain the collective output and maximising individual benefit will lead to collective ruin, where societal benefit will not be maximised. Hardin, however, fails to make the distinction between situations of no property (open access) and situations of common property.

His model is best fit for the situations of no property or open access and not the situations of common property. Therefore, the tragedy of the commons is a pessimist conclusion posed by Hardin. T

he two key assumptions of prisoner's dilemma model - players choose in ignorance of each other's choices, and each player chooses only once before the payoffs are received - become responsible for such pessimist conclusion.

Economic Approaches to Resource Management

In **economics approaches** to resource management, the common denominator is typically some form of measurement that can be related to individual welfare. Economics provides a comprehensive framework for analysing most aspects of natural resource and environmental issues. Optimal extraction and use of non-renewable resources, in particular as analysed by the Hotelling's rule. Economic indicators of sustainability derived from the weak sustainability view that the total amount of capital must be maintained. The basic Hotelling Rule is based on a number of simplifying assumptions. The total stock of resources is assumed to be known and of equal quality, and all the market players are assumed to have full knowledge. The concept of management of non-renewable resources is mainly concerned with how a resource stock should be used optimally and not concerned with sustainability.

Major issues in use of natural resources – productivity, equity & sustainability

Sustainability:

The word sustainability is derived from the Latin *sustinere* (tenere, to hold; sus, up). The most widely quoted definition of sustainability and sustainable development, that of the Brundtland Commission of the United Nations on March 20, 1987: "sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Environmental, social and economic demands - the "three pillars" of sustainability. The word sustainability is applied not only to human sustainability on earth, but too many situations and contexts over many scales of space and time, from small local ones to the global balance of

production and consumption. Sustainability is the capacity to endure. In ecology, sustainability describes how biological systems remain diverse and productive over time, a necessary precondition for human well-being. Long-lived and healthy wetlands and forests are examples of sustainable biological systems.

Sustainability farming: It is the system that in which NRS are managed so that the potential yield and stock of NRS do not decline over time

Principles and concepts

The philosophical and analytic framework of sustainability draws on and connects with many different disciplines and fields. In recent years an area that has come to be called sustainability science has emerged. Sustainability science is not yet an autonomous field or discipline of its own, and has tended to be problem driven and oriented towards guiding decision-making.

Scale and context

Sustainability is studied and managed over many scales (levels or frames of reference) of time and space and in many contexts of environmental, social and economic organization.

Consumption — population, technology, resources

The total environmental impact of a community or of humankind as a whole depends both on population and impact per person, which in turn depends in complex ways on what resources are being used, whether or not those resources are renewable and the scale of the human activity relative to the carrying capacity of the ecosystems involved. To express human impact mathematically called as I PAT formula. This formulation attempts to explain human consumption in terms of three components: population numbers, levels of consumption and impact per unit of resource use, which is termed technology used.

The equation is expressed:

$$I = P \times A \times T$$

Where: I = Environmental impact,

P = Population,

A = Affluence,

T = Technology

Measurement

Sustainability measurement is a term that denotes the measurements used as the quantitative basis for the informed management of sustainability. The metrics used for the measurement of sustainability (involving the sustainability of environmental, social and economic domains are evolving: they include indicators, benchmarks, audits, sustainability standards and certification systems.

Resource productivity:

Resource productivity is the quantity of good or service (outcome) that is obtained through the expenditure of unit resource. This can be expressed in monetary terms as the monetary yield per unit

resource. Resource productivity and resource intensity are key concepts used in sustainability measurement. The sustainability objective is to maximize resource productivity while minimizing resource intensity

List of environmental issues

- Climate change
- Conservation
- Energy Environmental degradation
- Environmental health
- Intensive farming
- Land degradation —
- Soil
- Land use
- Overpopulation
- Ozone depletion
- Pollution
- Water pollution
- Air pollution
- Reservoirs Resource depletion
-

Equity and issues in equity of natural resources

Equity derives from a concept of social justice. It represents a belief that there are some things which people should have, that there are basic needs that should be fulfilled, and that policy should be directed with impartiality, fairness and justice towards these ends .Equity means that there should be a minimum level of income and environmental quality below which nobody falls.

Intra-generational equity

Equity can also be applied across communities and nations within one generation. The reason that intra-generational equity is a key principle of sustainable development is that inequities are a cause of environmental degradation. Poverty deprives people of the choice about whether or not to be environmentally sound in their activities.

Equity issues, key parameters and indicators:

Key parameters and indicators

First, the majority of people would be deprived in terms of low welfare level despite their hard work (equity failure),

Second, unfair access to public infrastructure, facilities and services could occur (equity failure). i.e . Failure to guarantee intra- and inter-generational equity would cause deep inequality and un sustainability

Third, natural resources may be so exploited that threaten their sustainability of use.

Fourth, negative externalities of economic activities could create serious threat to the environment

Equity issues:

Nine Equity Issues are

1. Income and employment system
2. Access to facilities and services
3. Access to natural resources
4. Fairness in competition
5. Natural resource exploitation
6. Negative externalities
7. Non-production function
8. Compensation to worse
9. Sustainability reinvestment