Farm Management, Production & Resource Economics

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Lesson Number	Lesson Title
Lesson 1	Concept of Farm Management (FM)

Lesson 2	Types of Farm and Size of Farms
Lesson 3	Production Function
Lesson 4	Factor-Product Relationship
Lesson 5	Factor-Factor Relationship
Lesson 6	Product-Product Relationship
Lesson 7	Law of Equi-Marginal Returns and Law of Comparative Advantage
Lesson 8	Cost Concepts, Types, and Their Interrelationships
Lesson 9	Managing Farm Business: Importance of Cost, Estimation of Farm Business Income, and Efficiency Measures
Lesson 10	Farm Records
Lesson 11	Linear Programming and Appraisal of Farm Resources
Lesson 12	Risk and Uncertainties in Agriculture
Lesson 13	Crop/Livestock/Machinery Insurance – Weather-Based Crop Insurance, Features, Determinants of Compensation
Lesson 14	Resource Economics
Lesson 15	Externalities in Agriculture
Lesson 16	Economics and Management of Common Property Resources

Course Name	Farm Management, Production & Resource Economics
Lesson 1	Concept of Farm Management
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Objectives:

- To understand the concept of FM, its importance and scope
- To understand nature and characteristics of FM and its relationship with other sciences

1. Glossary of terms

Farm Management (FM) comprises two words 'farm' and 'management'. Similarly, there are other related concepts like firm, farm-firm that we can understand.

Farm: It is a piece of land where crop and livestock enterprises are taken up under a common management and has specific boundaries.

Management: It means the act or art of managing the farm.

Firm :A firm is a for-profit business organization—such as a corporation, limited liability company (LLC), or partnership—that provides professionalservices.

Farm-firm: the farm firm will be regarded as a managerial unit in which labor and physical capital are applied to land in order to produce primary farm products.

2. Farm Management concept

Like any other economic problem farm management is a rational resource allocation proposition more particularly from the point of view of an individual farmer. One an hand, a farmer has a certain set of farm resources such as land, labour, farm buildings, working capital, farm equipment, etc., that are relatively scarce. On the other side, the same farmer has a set of goals of objectives to achieve, may be maximum family satisfaction through increasing net farm income. In between these two poles is the farmer himself with specific degree of ability and awareness. This gap is bridged by the mental exercise and concentration of desire and will power of the individual farmer, to use his scarce resources in a way that desired objectives are levied. This bridging up

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process necessitates taking a series of rational decisions in respect of farm resources having alternative uses and opportunities

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

According to Prof. Gray "The art of managing a farm successfully, as measured by the test of profitableness is called farm management".

Farm management seeks to help the farmer in deciding problems like what to produce, how much to produce and when to buy and sell and in organizations and managerial problems relating to these decisions.

Farm management may in short be called a science of decision making or a science of choice. It is to be emphasized that managing a farm is a continuous process of decision making. The need for it arises out of changes occurring outside of the farm; hence need of continuous adjustment of farm operations to these changes frequently encountered by the farmer are fluctuations in prices; weather variations, inventions in farming methods, changes in socio-economic environment including changes in government policy and social responses and values.

What makes a successful farm manager?

1. Farmer acting on the goal or objectives of the farm
2. Recognition and definition of a problem or opportunity
3. Obtaining information – observation of relevant facts
4. Specification and analysis of alternatives
5. Decision-making – choosing an alternative
6. Taking action
7. Bearing responsibility for the decision or action taken
8. Evaluating the outcome.

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3. Scope of FM

- 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 allocations 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 farmer.
- Thus, the type 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

4. Importance of FM

- Through the process of mechanization, automation, communication and modernization, farm has gone beyond its framework of mainly providing the necessities of life to the farm family.
- Now the farmer produces not only to meet his family subsistence needs, but at the same time he endeavors to produce maximum surpluses to be sold in the market to buy some non-farm products for fuller satisfaction of life.
- This has made agricultural production market oriented and as introduced a business output in the farm profession.

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5. Nature and characteristics of FM science

FM is practical science:While dealing with the facts of other physical and biological sciences, it aims at testing the applicability of those facts and findings and showing how to put these results to use on a given situation. Threshing of wheat for example, can be done by different methods such as *phalla* system disc thresher, power thresher, tractor, fodder culture, etc. All these methods have their own weak and strong points. A farmer has to select a method which is more practicable and economical to his particular farm situation taking into consideration the volume of work and financial implications.

- ***FM is profitability oriented:*** Physical scientists always concern themselves with obtaining maximum yield irrespective of profitability of inputs used. But the farm management specialist always considers the costs involved in producing each unit of output in relation to returns and decides the optimum level of production. He has to consider all relevant factors such as financial implications, marketing, transportation and storage facilities and costs. In the decision making process profitability is thus the major criterion of selection / adoption of an enterprise or practice. Other science deals with physical efficiency, the farm management concerns with economic efficiency.
- ***FM is an integrating science:*** It is an integrating science in a sense that the facts and findings of other sciences are coordinated for the solution of various problems of individual farmers with a view to achieving certain desired goals. It considers the findings of other sciences in reaching its own conclusions. Most of the physical sciences throw out results having usefulness under specific set of conditions. The principles of farm management help integration of these results to reach at optimum combination of practices under the frame work of restraints of individual farm situations.

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- ***FM is broader field***: Farm management decisions are made by getting information from more than one discipline. Most of the physical sciences concern themselves within narrower compartments of information. A farm management specialist has to know the broad principles of all other concerned sciences in addition to specialization in the business principles of farm management. It is thus a much broader field, because it has to gather knowledge from many other sciences for making its own decisions. A farm management specialist has become thus a "Jack of many trades and master of one"
- ***FM is micro approach:*** It treats every farm unit unique in available resources, problems and potentialities. It requires that no two farms are exactly identical with respect to soil, other production resources, farmers' managerial ability etc. Each farm unit has to be therefore, studied, guided or planned individually. The major emphasis of this approach lies on treating the farm as an operational unit and tailoring the recommendations to fit into its resource position. Recommendations tailored to suit particular farm situations instead of blanket recommendations an important approach of the farm management extension education.
- ***Farm as a unit:***The objective of FM is to maximize the returns from the whole farm instead of only improving the returns from a particular enterprise or a practice. No agronomist will tell a farmer how to utilize his surplus labour and scarce capital by taking up supplementary enterprises. The sciences like horticulture, dairy etc. are similarly concerned with only one aspect of the whole farm business.

6. Relationship of FM with other sciences

a) **Physical and biological sciences:** FM has to depend on other physical and biological sciences for its source material. These sciences provide the input-output relationships in respective areas

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in physical terms i.e., they define production possibilities within which various choices can be made. Agronomy discipline provides input-output relationships in crop production. Animal sciences**:** refers to gain in live-weight associated with feed rations. Soil scientist: dose of fertilizers

b) **Economic Theory:** FM as a subject matter is the application of business principles in farming from the point of view of an individual farmer. The tools and techniques for farm management are supplied by the general economic theory. Law of variable proportions, the principles of substitution and the marginal analysis are all instances of tools of economic theory used in farm management analysis.

c) **Other Social Sciences:**

Psychology: provides information on human motivation and attitudes. In decision making many psychological aspects and mental reservations of decision maker come in, such as attitude towards taking likes and work under conditions of uncertainty.

Sociology: The farmer lives and works in a given a social matrix.His decisions are influenced by the customs, habits and cultural values of the society in which he lives. Similarly, many decisions are made by the family jointly. Sociology, which deals with social problems, responses and reactions of the rural people vis-à-vis their main occupation. i.e., agriculture has a great bearing on the farm management decisions the farmers make.

Political science: Various pieces of legislation and political actions of the Govt. affect the production decision of the farmer such as scale of production, restrictions or encouragement on growing of certain crops such as poppy, tobacco in India, land utilization, ceiling on land, minimum and maximum prices, food zones, etc.

Supplementary sciences (statistics): It is extensively used by the agricultural economists and farm management specialists. The statistics is helpful in providing methods and procedure by which

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data regarding specific farm problems can be collected, analyzed and evaluated.

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Lesson 2	Types of Farm and Size of Farms
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Objectives:

- To understand the nature and characteristics of different types of farming,
- To understand the factors determining types and size of farms

Glossary of terms

Hectare (symbol: **ha**): is unit of area equal to 10,000 m^2, and is primarily used in the measurement of land. There are 100 hectares in one square kilometer. An acre is about 0.405 hectare and one hectare contains about 2.47 acres.

Monoculture is the agricultural practice of growing a single crop, plant, or livestock species, variety, or breed in a field or farming system at a time.

Polyculture where more than one crop species is grown in the same space at the same time, is the alternative to monoculture.

A **vineyard** is a plantation of grape-bearing vines, grown mainly for winemaking, but also raisins, table grapes and non-alcoholic grape juice. The science, practice and study of vineyard production is known as viticulture.

Corporate farming is the practice of large-scale agriculture on farms owned or greatly influenced by large companies

1. Meaning and definition of farms, Farm Sizes, classification of farm size

A farm may be owned and operated by a single individual, family, community, corporation or a company, may produce one or many types of produce, and can be a holding of any size from a fraction of a hectare to several thousand hectares.

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A farm may operate under a monoculture system or with a variety of cereal or arable crops, which may be separate from or combined with raising livestock. Specialist farms are often denoted as such, thus a dairy farm, fish farm, poultry farm.

Some farms may not use the word at all, hence vineyard (grapes), orchard (nuts and other fruit), market garden or "truck farm" (vegetables and flowers). Some farms may be denoted by their topographical location, such as a hill farm, while large estates growing cash crops such as cotton or coffee may be called plantations.

Many other terms are used to describe farms to denote their methods of production, as in collective, corporate, intensive, organic or vertical.

“Farm sizes or size of farm is generally understood in terms of physical area, volume of production and value of production”

In general, size of farm refers to physical area, but in terms of economics this refers to either with the volume of production or value of production.

- **Minimum efficient size**; “The minimum size of a farm should be such as will keep the farmer fully employed and will just provide him with an income sufficient to sustain himself and his family”
- **Economic Size of a Farm:** it could be stated that the economic size of a farm should allow a man the chance of producing sufficient income to support himself and his family in a reasonable comforts after paying his necessary expenses
- **The family farm:** is one in which all the factors of production would be wholly within the family farm. Hence the economic size of the farm should be somewhat larger than the minimum efficient size and it should provide a reasonable standard of living to the family.
- It is not easy to determine the economic size of the farm for the country as a whole. It will vary from place to place.
- It should be studied in relation to specific region, in terms of fertility and location of the farm, irrigation facilities, nature of crops grown,

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amount of capital available for investment and managerial capacity of the farmers

2. Types of farming

Types of farming refers to the nature and degree of products and their combination and various methods followed in the production of the same.

The major types that studied are

- Specialized farming.
- Diversified farming.
- Mixed farming.
- Dry farming.
- Ranching.

2.1. Specialized farming

When a farm unit derives more than 50 percent of its income from a single enterprise it is called as a specialized farm.

The reasons for specialized farming are

- Assured income from the enterprise.
- Its suitability to the area.
- Its relative profitability etc.

Advantages of specialized farming

- Better utilization of land:
- Better management:
- Less requirement of equipment
- Increase in skill of the farmer
- Allows better marketing

Disadvantages

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- Failure of crops
- Non- utilization of productive resources
- Affect soil health

2.2. Diversified farming

- There is no much significance for a single enterprise under this situation.
- No single enterprise contributes as high as 50 percent of the total income derived in farming.

Advantages

- Better utilization of farm resources
- Reduction of farm risks
- Flow of income

Disadvantages

- In effective supervision
- Less possibility for maintaining a variety of implements and machinery
- Probable marketing insufficiencies

2.3. Mixed farming

- It represents a type of farming in which crop production and livestock are combined to sustain and satisfy many needs of the farmer as possible.
- There are limits specified regarding contribution of livestock production, poultry, fisheries and beekeeping, etc to the gross income on the farm.
- These enterprises are supposed to contribute at least 10 percent of gross income.
- However this contribution should not exceed 49 percent.

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Advantages

- Facilitates the application of organic manures thereby helps in maintaining the soil health.
- It provides employment to the farmer and his family throughout the year.
- Agricultural by products are properly used in mixed farming.
- It further provides a sort of stability to the farm business.

2.4. Dry farming

Growing of crops entirely under *rainfed* conditions is known as dry land agriculture.Depending on the amount of rainfall received, dry land agriculture is categorized into

- Dry farming,
- Dry land farming and
- *Rainfed* farming.

Dry farming: Means cultivation of crops in areas where rainfall is less than 750 mm per annum. Crop failure is the most common feature. Dry farming region is equivalent to arid regions and moisture conservation practices are necessarily implemented in this region.

Dry land farming: is the cultivation of crops in region with an annual rainfall of more than 750 mm. Dry spells during crop period occurs but crop failures are relatively less frequent. Moisture conservation practices are necessary for crop production.

Rainfed farming: is crop production in regions with an annual rainfall of more than 1150 mm. It is practiced in humid regions where crop failures are rare and drainage is the important problem.

2.5. Ranching

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Refers to the practice of grazing animals on the public lands. Some public lands may also be used for raising livestock. The practice is common in Australia and Tibet. In India, ranching is prevalent, to some extent, in the hilly regions that are rich in pastures and grazing lands.

Ranching is the practice of raising herds of animals on largetracts of land. Ranchers commonly raise grazing animals such as cattle and sheep. Some ranchers also raise elk, bison, emus and alpacas. The ranching and livestock industry is growing faster than any other agricultural sector in the world.

Advantages of Ranching

- Provides manure
- No investment on land
- Close supervision
- Easy to manage
- Higher returns

Disadvantages of Ranching

- Destroys crops
- Land degradation and desertification
- Air and water pollution
- Spread of diseases

3. Factors influencing types of farming

It is influencing by several factors. These factors can be broadly grouped into two categories.viz., physical factors and economic factors.

A. **Physical factors**

(1) Climate

(2) Soil

(3) Topography

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B. Economic factors:-

- Relative profitability
- Availability of funds
- Availability of the inputs
- Marketing arrangements
- Personal choices

4. Types of Farm Business Organization or Systems of Farming

System of farming is related to ownership and operatorship of farming

4.1. Peasant farming:

- This is the most commonly followed form of business organisation.
- Individual farmer is the owner, manager and organiser of the farm. He is totally independent in his decisions.
- Resource limitation is the drawback of this farming.

4,2. Cooperative farming

It is a form of farm business organisation in which persons unite voluntarily pool their lands, resources, and cultivate the lands jointly. The birth of cooperative farming took place in Palestine. Jews from Palestine are the pioneers who have organized these societies.

The all India cooperative planning committee (1951) classified the cooperative farming in to four categories

- Cooperative better farming society.
- Cooperative joint farming society.
- Cooperative tenant farming society.
- Cooperative collective framing society

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4.2.1 Cooperative better farming society.

Ten or more farmers can form a society. Ownership as well as operatorship is individual. All members abide by a plan of cultivation adopted by the society. The society arranges for the adoption of better methods of cultivation, joint purchase of inputs, etc. Every member is free to follow his own plan except for the purposes agreed. The administration is done by a managing committee elected by the general body and it governs all the activities.

4.2.2 Cooperative joint farming society

Ownership is individual and operatorship is collective. Individual owners of land merge their lands and other resources in order to form into compact blocks for joint cultivation. The management of the society is in the hands of an elected body. All the members work jointly and each member gets wages for their daily work. The ownership of the land is recognized by the payment of dividend in proportion to the value of land.

4.2.3 Cooperative tenant farming society

In this case landless people organise a farming society. Here the ownership is collective but the operation is individual. Land of the society is divided into plots and leased out by cultivators to individual cultivators. Society draws a plan for the best cultivation of the land. The society arranges for the cultivation requirements and also the marketing of the products. Every member is responsible for the payment of rent to the society.

4.2.4 Cooperative collective farming society

Ownership as well as operation is collective. Members do not have any rights on land. Administration is same as the joint farming society. Members work jointly and they are paid according to the volume of work contributed. Profits are distributed according to the capital and labour invested by the farmer.

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4.3 Capitalistic Farming

The farms are large and owned by the capitalist. These farms enjoy plentiful resources. These are managed by either individuals or group. These farms are quite efficient using the latest technology available. Capitalistic farms are popular in countries like USA, Canada, UK, etc. Farms enjoy plenty of capital and organizational strengths. The limitation of this type of farm business organisation is that the actual cultivator is not the owner of the farm.

4.4. Collective Farming

It is a group of farming families who pool their resources that is livestock, machinery, etc and undertakes to work together under the management committee elected by them. The committee is responsible for the overall farm management, allocation of work and distribution of income. Russia and China follows this. The production plan on the farms is laid down by the state and the farms have to sell fixed portion of the output to the state. Incentives are paid to the farmers for the improvement of the farm.

4.5. State Farming

These farms are owned, managed and run by the state. State farms are equipped with latest machinery and equipment and employ scientific methods of cultivation. The workers on these state farms are wage earners. Besides producing food grains, the state farms produce raw products like cotton, wool, etc. State farming is suitable in newly reclaimed areas, where large scale mechanized cultivation is possible.

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Lesson 3	Production Function
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Objectives:

- To understand the concept of production function and the types of PF,

Glossary of terms

Production is a process whereby certain goods and / or services are used to create goods and or services of a different nature. Or Production means creation or addition of utility or values.

Input/Factor/Resource: Anything that aid in production.

Variable resource: The level of use of resource vary with the level of output

Fixed resource: The level of use of resource remains same irrespective of level of output.

Short run: The period which is sufficient to alter only variable resources.

Long run: The period which is sufficient to alter all resources (all resources are variable)

1. Concept of Production Function

Level of output of a particular commodity depends upon the quantities of inputs used for its production. This relationship between inputs and outputs can be characterized as a production function. Production function is thus 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.

In the production function output is "dependent upon" or "determined by" or "related to" or is the "function of" inputs or the use of resources.

Production function is of two types

a) Continuous function
b) Discontinuous or discrete function

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a) Continuous function:

Can be explained by response of yield to fertilizer or seeds where the doses or levels of inputs and output can be split up into small units, eg. Fertilizers can be applied to a hectare of land in quantities ranging from a fraction of a kilogram up to hundreds of kilograms. Labour is also quite divisible because it can be used in minutes or in terms of man hours. Indivisible inputs can also be used indivisible units e.g. tractor input can be varied by using a tractor more or less number of hours per day, employing tractors of various sizes, substituting second hand for a new tractor and hiring tractor services, etc.

b) Discontinuous or discrete function :

Such a function is obtained for inputs/ factors or work units which are used or done in whole numbers such as one ploughings. One can only shift from one point to another. In discrete functions, the alternative decision points get limited; otherwise some method of analysis is followed in both continuous and discrete production functions.

2. Transformation or production period and types of PF

Time required for a resource to be completely transformed into a product is referred to as transformation period or the production period. The production period varies with resources. The production or the transformation period gives rise to complexities in decision making.

2.1 Short & long run production functions

Production function which relates to factors and products where some resources are fixed (regardless of the number of fixed resources and the level at which each is held fixed) can be termed as short run production function. Those input – output relations which perform variation in the input of all factors (none is fixed) can be termed as long run production functions.

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The production function implies the relationship between the physical outputs and inputs used by a farm firm. It can be expressed as

$Y = f(x_1, x_2, x_3 \ldots\ldots x_n)$

Where Y = quantity of farm output $x_1, x_2, x_3 \ldots\ldots x_n$ stand for quantities of factors $x_1, x_2, x_3 \ldots\ldots x_n$. This equation shows that total farm output y depends upon the quantities x_1, x_2, $x_3 \ldots\ldots x_n$ of the factors x_1, x_2, $x_3 \ldots\ldots x_n$ respectively. This equation clearly shows that there exists some relationship between output Y and the quantities of input $x_1, x_2, x_3 \ldots\ldots x_n$ etc. But it fails to tell us the specific firm which this relationship will assume. This unspecified relationship has been denoted hereby the letter 'f'. This function becomes specific if we could find out the value of output Y when the values of the independent variables $x_1, x_2, x_3 \ldots\ldots$xn are given.

Production function can be expressed in three forms viz., tabular, graphic and algebraic

Tabular

Yields response data of wheat grains (Q) to fertilizer (N) used in kilograms per acre

Fertilizer (N) Input X	**Total yield Output (Y)**
0	2
10	5
20	11
30	18
40	25
50	31

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Graphic form

The same data can be presented in the form of a graph as

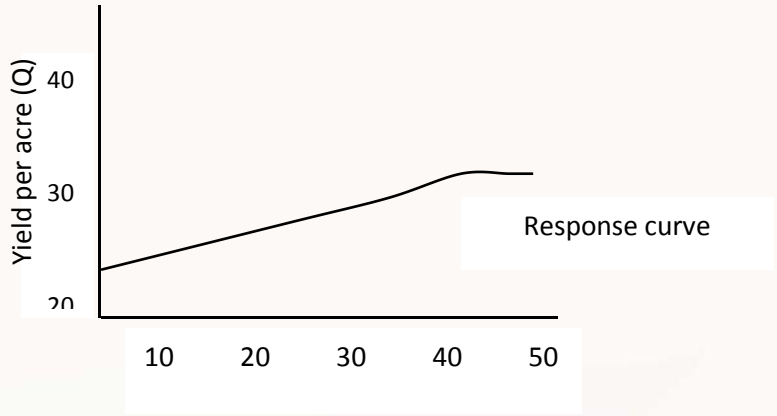

Fig : Graphic presentation of factor – product relationship

Algebraic form: Algebraically P.F. can be expressed as Y = f(x)

Where Y represents dependent variable such as yield of a crop, egg production, milk yield and x represents independent variable such as fertilizer, labour, feed etc. and 'f' denoting 'function of'.

If the independent variables are two

$Y = f(x_1, x_2)$

For a number of independent variables

$Y = f(x_1, x_2, x_3 \ldots\ldots\ldots\ldots x_{n-1}, x_n)$

Normally, there are more than one independent variables involved in the production of a commodity. In the case of a single variable production function only one variable is allowed to vary whereas others are held constant such a function where one independent variable changes and others are held constant can be expressed as

$Y = f(x_1 / x_2\ x_3 \ldots\ldots\ x_{n-1})$

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If more than one independent variable changes and a few other are held constant the relationships can be expressed as

$Y = f(X_1, X_2.....X_{n-1},X_n/X_{n+1},X_{n+2}.....X_{n+k})$

Where X_1 to X_n factors are variable and X_{n+1} to X_{n+k} are fixed factors.

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Lesson 4	Factor – Product relationship
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Objectives

1. To understand the types of production relationships
2. To understand the behavior of output with variation in the single variable input keeping the other resources at some constant level
3. To understand the decision making criteria to use the optimum quantity of variable input to be used

Glossary

Marginal: In economics, it means having a little more or a little less of something. It refers to the effects of consuming and/or producing one extra unit of a good or service.

Product: Product is the result of use of resources or use of resource services. A product can be a service or an item. It can be physical or in virtual or cyber form. Every product is made at a cost and each is sold at a price.

Variable factor: The input or factor that is allowed to vary in the production process.

Fixed factor: The factor/s which is/are not allowed varying in the production process.

Total Product (TP): Refers to the total number of units of output produced per unit of time by all factors/inputs.

Average Product (AP): is the ratio of total product to quantity of the variable factor/input.

Marginal Product (MP): is the rate of change in the total product to a unit change in the variable input.

Optimum: refers to the amount or degree of something that is most favorable to some end.

Types of production relationships

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Usually, the farmer producers face the following type of situations in making decisions due to resource constraints or due to problems in combining the resources and products.

1. Farmer may wish to produce a certain amount of commodity / produce having a certain amount of resource to use he will have to decide the most profitable resource to use in the production of a commodity (Factor – product).
2. Having a certain combination of resources, he may have to decide the most profitable combination to use to produce a specific amount of a given output (Factor-Factor).
3. Having a certain combination of resources, he is also faced with the problem of choosing the most profitable mix of products to produce (Product –product).

The above situations lead to three kinds of production relations

1. Factor- product
2. Factor-Factor
3. Product-Product

1. Factor-product relationship

We proceed first with simple situations to understand the basic principles by confirming ourselves to physical factor – product relationships of a single variable resource and single product. This situation is realistic also. Many times resources or capacities of technical units, such as an acre of land or a cow, are fixed and choice is to vary the input of only one factor, such as fertilizer or labours, Fertilizer application to an acre of land, feed to a dairy cow or a unit of birds can for example be varied while other inputs such as fixed capital, buildings, technical know-how remains the same under such a situation pertinent question would be how much fertilizer to apply? How much feed to be given to a cow or a unit of birds? Such situations involve single factor –single product relationships. They are known as single variable production functions too. In a production function various levels of an input are involved with corresponding outputs of the product. Thus production

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function refers to the quantitative aspects of the process of production. The kind of product and the amount of product depends upon or is a function of the kind and quantity of inputs used. There can be three types of input - output relationships in the production of a commodity where one input is varied and the quantities of all other inputs are fixed. The nature of relations can be

1.1 Constant marginal returns (constant productivity)
1.2 Increasing marginal returns (increasing productivity)
1.3 Decreasing marginal returns (decreasing productivity)

1.1. Constant Marginal Returns Function

In constant relationships or linear relationships each additional unit of the variable input when applied to the fixed factor (s), produces an equal amount of additional product i.e., the amount of product increases by the same magnitude for each additional unit of input. This is not a very common relationship in agriculture and holds true only within a limited range. As an example, each addition of one acre of land (technology and other factors remaining the same) will add the same amount of product. Again, employment of an additional tractor plus driver will lead to the same amount of work as a previous tractor and driver unit did. A hypothetical numerical example on further response data will make the relationship further clear.

Tabular

Table 1.Constant relationship – Fertilizer response functions (Hypothetical data)

Doses of fertilizer (Rs.) X	**Marginal dose X**	**Total production of wheat (Kg) Y**	**Marginal yield (kg) Y**	**Marginal rate of returns (kg) Y/X**

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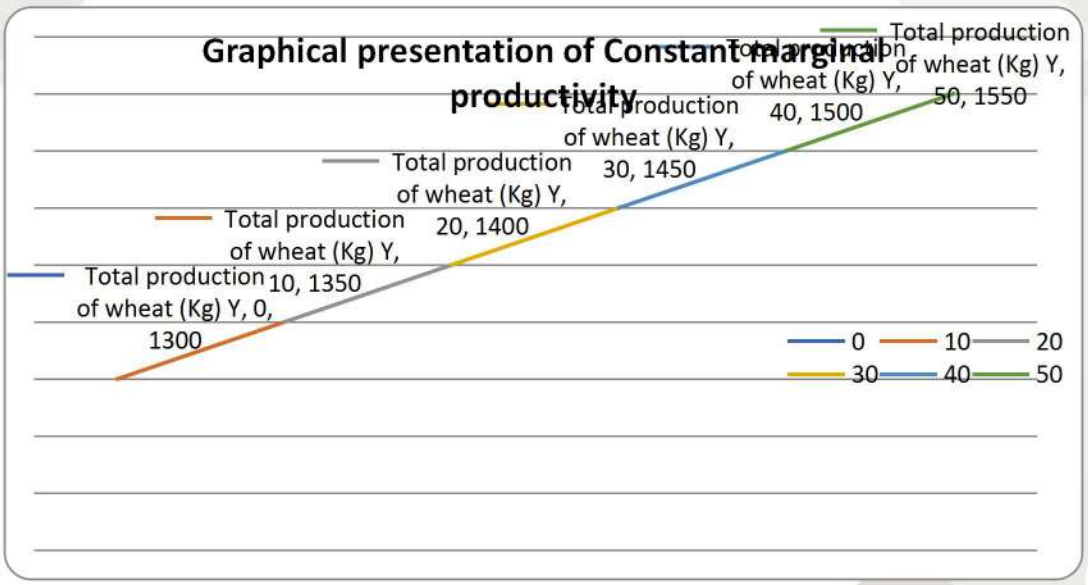
0	-	1300	-	-
10	10	1350	50	50/10=5
20	10	1400	50	50/10=5
30	10	1450	50	50/10=5
40	10	1500	50	50/10=5
50	10	1550	50	50/10=5

The relationship in Table 1 shows that with every increase in input, there is equal or constant increase in the level of output. It is known as a constant marginal returns function.

The production function in the above figure is a straight line having the same slope throughout its entire range this relationship can also be expressed as

$$\frac{\Delta Y_1}{\Delta X_1} = \frac{\Delta Y_2}{\Delta X_2} = \ldots\ldots\ldots\ldots = \frac{\Delta Y_3}{\Delta X_3}$$



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The constant returns production function can be presented by an algebraic equation of the form Y = a + bx

The estimated equation of the example given above is Y = 1300 + 5x. This shows that 1300 kg of wheat are produced without applying fertilizer and wheat output (y) increases by 5 kg for every increase of one kilogram of the fertilizer.

Linear production functions do not exist when inputs per acre or per animal are intensified. Such a relationship only exists where the initial doses applied per acre are very small. The additional doses applied at this stage give constant returns within such a small range. Agronomists and soil scientists sometimes make recommendations as of the production function were linear, which of course is never true in real practice. Before making any recommendations, one should therefore, carefully considers the nature of return and economic criteria.

1.2. Increasing marginal returns function

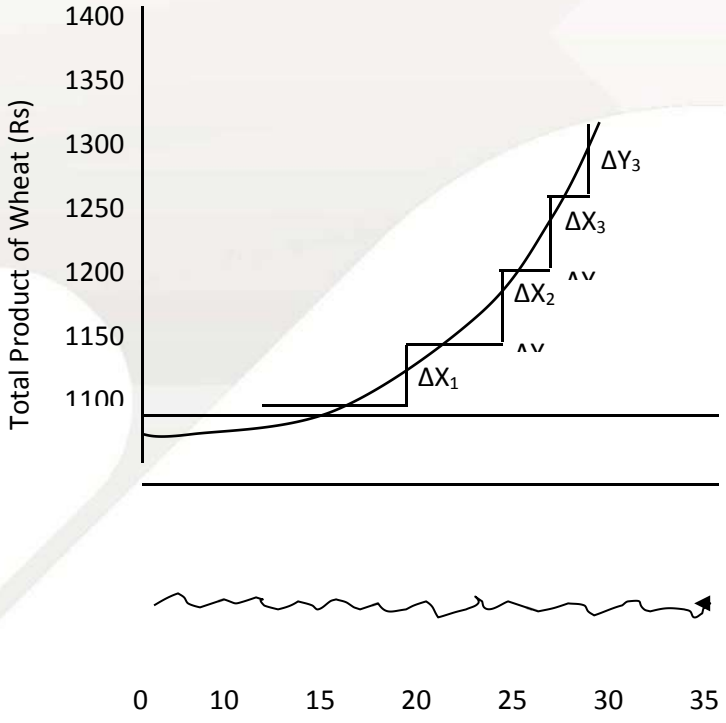
In this case, every additional or marginal unit of input adds more to the total product than the previous unit i.e., addition to total product is at an increasing rate. In actual practice, the cases of purely increasing returns are rarely available except, again in very limited range. This relationship is possible when the fixed factors of production are in excess capacity and addition of the small units of a variable resource makes more and more efficient use of fixed resources. For example, small quantity of wheat seed applied when other factors of production such as fertilizer, irrigation and other cultural practices can be used at high levels will give low returns and as the quantity of seed increases from a very low level. It might provide a case of increasing marginal returns.

Table 2. Response of different seed rates on wheat yield

Wheat seed rate (Kg)	Marginal dose (Kg)	Total production of	Marginal production Y	Marginal rate

		wheat (Kg)		Y/X
10	-	1000	-	-
15	5	1025	25	25/5=5
20	5	1075	50	50/5=10
25	5	1150	75	75/5=15
30	5	1250	100	100/5=20
35	5	1375	125	125/5=25

Graphically



The shape of the curve will go steeper and steeper with the added inputs i.e., slope gets convex to the origin. In this case the following relationships holds true.

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$$\frac{\Delta Y1}{\Delta X1} < \frac{\Delta Y2}{\Delta X2} < \frac{\Delta Y3}{\Delta X3} < \ldots\ldots\ldots < \frac{\Delta Yn}{\Delta Xn}$$

This means that ratio $\frac{\Delta Y}{\Delta X}$ will go on increasing as more and more units of input are added.

1.3. Decreasing marginal returns function

In this type of function, each additional unit of input adds less to the total product than the previous unit did. Diminishing marginal returns exist, for example, if the first input adds 20 units, to the total output while the second adds 15 units, the third adds 10 units, fourth adds 5 units and so on.

This function exists in almost every practical situation in agriculture. Responses to fertilizers, insecticides seeds, irrigation, feeds, etc all show diminishing returns.

Table 3. Application of fertilizers and output of wheat.

Fertilizer input X	Marginal dose X	Total wheat production (Kg)	Marginal production Y	Marginal rate of change Y/X
0	-	500	-	-
10	10	1400	900	900/10=90
20	10	2100	700	700/10=70

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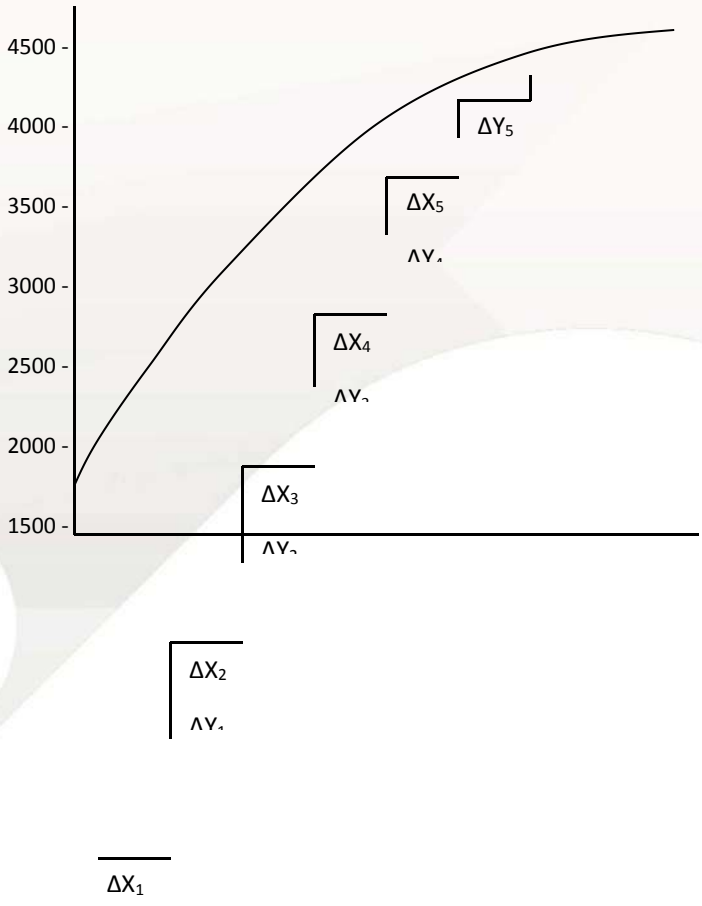
30	10	2600	500	500/10=50
40	10	3000	400	400/10=40
50	10	3300	300	300/10=30
60	10	3500	200	200/10=20

This table shows that every time 10 units of fertilizer are added, the marginal addition to the total output goes on decreasing.

Graphically



The curve in the above fig. is concave to the origin. This relationship can also be indicated as follows

$$\frac{\Delta Y_1}{\Delta X_1} > \frac{\Delta Y_2}{\Delta X_2} > \frac{\Delta Y_n}{\Delta X_n}$$

Since $\Delta X_1 = \Delta X_2 = \Delta X_3 = \Delta Xn$ in this diagram, the ratio ΔY goes on decreasing as higher and higher input level is adopted.

This is a technological law of biological responses and is applicable in almost all practical situations of agricultural production under varied farm situations. Before taking any decisions, however, one needs to have an understanding of the concepts of total, average and marginal products and their relationships as well as factor product price ratios.

2. Relationship Between Total, Average And Marginal Products

Since both average and marginal products are derived from total product curve. These curves are shown in fig. and correspond to the data in table

2.1. Total Product (TP)

A given level of total product is always associated with a particular level of input(s) use with a given production technology. Production functions are often presented as total output curve because total product curve and production function are closely associated.

2.2. Average Product (AP)

The term average product refers to the average productivity of a resource. It is ratio of total product (TP) to the quantity of input used in producing that amount of product i.e. at any point on production function, it is the total output divided by the total input used.

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AP = $\frac{Y}{X}$ Where Y is product and x the input (s)

2.3. Marginal Product (MP)

The term marginal product refers to the quantity which (marginal) unit of factor – input adds to the total product. The marginal product (MP) at any level of the variable input can be approximated by dividing the addition to that output by the addition to the total input.

MP = $\frac{\Delta Y}{\Delta X}$ (Here Δ refers to "change in" or "add it is to" the product or input).

It is the rate of change in total product at a given point as the quantity of input changes. This marginal analysis is a very important tool available to the economists for treating optimal points. Although average productivity provides some guidelines as to the manner in which resources are allocated, it is marginal productivity which provides the final criterion in determining optimum use of limited resources.

Table 4.Relationships between total, average and marginal products (Hypothetical data)

Units of fertilizers input X	Total Product (TP) Y	Average Product AP = (Y/X)	Change in output ΔY	Change in input ΔX	Marginal Product MP = $\frac{\Delta Y}{\Delta X}$	Remarks
0	0	-	-	-	-	Increasing

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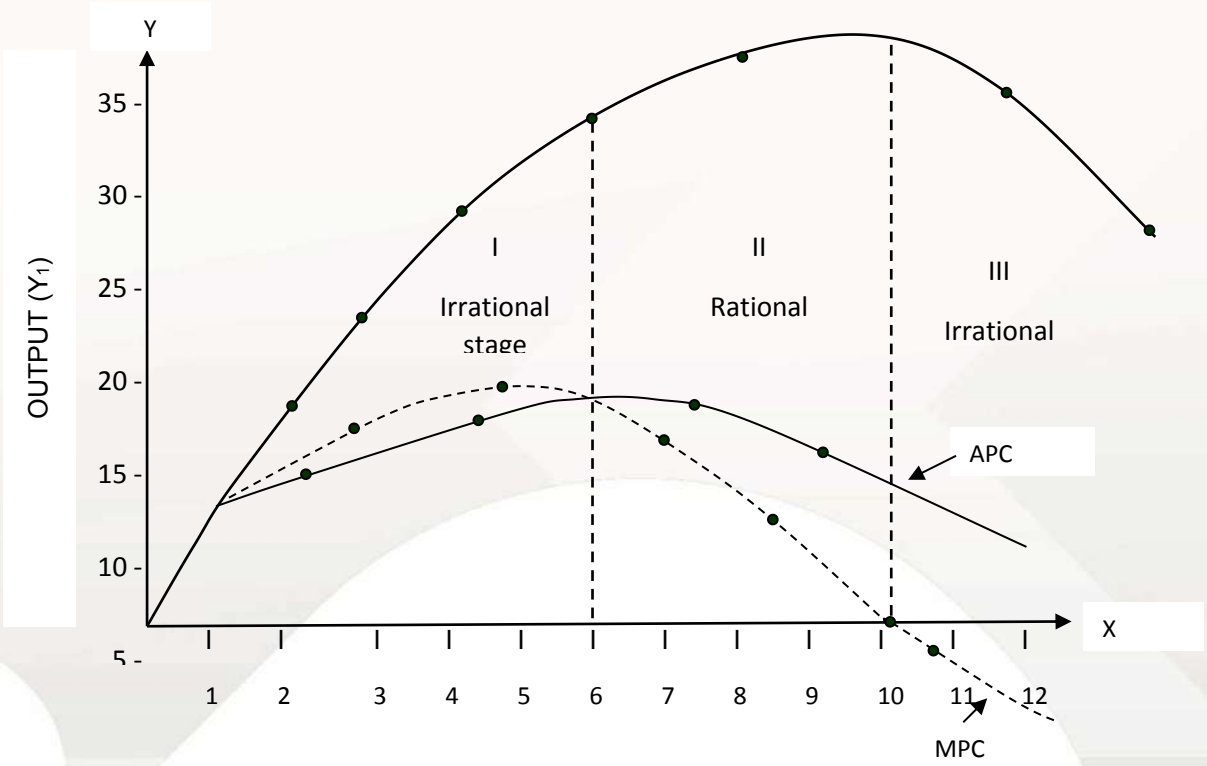
1	2	2	2	1	2	at increasing rate
2	5	2.50	3	1	3	
3	9	3.00	4	1	4	
4	14	3.50	5	1	5	Increasing at constant rate
5	19	3.80	5	1	5	
6	23	3.83	4	1	4	Increasing at decreasing rate
7	26	3.71	3	1	3	
8	28	3.50	2	1	2	
9	29	3.22	1	1	1	
10	29	2.90	0	1	0	
11	28	2.54	-1	1	-1	Decreasing at increasing rate
12	26	2.16	-2	1	-2	

2.4. TP & MP

Essential points to be noted in this relationship are

1. Since the MP is a measure of rate of change therefore.
   a) When total product is increasing the MP will be +ve
   b) When TP remains constant, the MP will be zero and
   c) If the TP decreases the MP will be –ve
2. As long as MP moves upward or increases, the TP increases at an increasing rate.

3. When the MP remains constant, the TP increases at a constant rate
4. When the MP starts declining or slope downward, the TP will be increasing at a decreasing rate.
5. At the point the MP becomes zero or MP curve intersects X-axis the total product will be at maximum.



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2.5. MP & AP

Points to be noted in this relationship are

1) When the MP keeps increasing or is moving upward right from the beginning, the AP curve also keeps moving upward. As long as MP curve remains above the AP curve, the AP curve keeps increasing. This means when the average product is increasing, the marginal product must be greater than the average product.
2) As soon as the MP curve goes below the AP curve the AP curve starts decreasing; i.e. MP is smaller than AP, AP is decreasing.
3) When AP is equal to MP, at this point AP will be at the maximum. Form here onward MP will change from greater to being less than average product, the MP curve must therefore intersect AP curve from above at its highest point.

The relationship between average product and marginal product can be summarized as

1. When MP > AP, AP is increasing
2. When MP > AP, AP is decreasing
3. When MP = AP, AP is at a maximum

3. Elasticity of production

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

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

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$$\frac{\Delta Y}{Y} * \frac{X}{\Delta X}$$

Or

$$\frac{X}{Y} * \frac{\Delta Y}{\Delta X}$$

$\frac{X}{Y} * MPP$ Since $\frac{X}{Y} = \frac{1}{APP}$

$\frac{1}{APP}$ x MPP

Hence, Ep = $\frac{MPP}{APP}$

Table 5.The point is illustrated with an example given below:

Fertilizer doses (X)	Total yield attributed Further (Y)	ΔY	ΔX	ΔY/Yx100	ΔX/Xx100	EP
1	103	-	-	-	-	-
2	174	71	1	68.93	100	0.689
3	223	49	1	28.16	100	0.282
4	257	34	1	15.25	100	0.153
5	281	24	1	9.34	100	0.093

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6	298	17	1	6.05	100	0.061
7	308	10	1	3.36	100	0.034

As input increases from 1 to 2 units, total output increases from 103 to 174 units output thus increases by 71 percent in response to increase by 100 percent, the elasticity of production (Ep) is = $\frac{68.93}{100} = 0.689$

Essential points to remember in elasticity analysis are

1) A production function with an elasticity of 1.0 (EP=100) indicates constant returns throughout. This means a one percent increase in input is always accompanied by one percent increase in output.
2) Elasticity is more than 1.00 up to the point of maximum average product where it becomes 1.0.
3) The elasticity is less than one between the points of maximum average product and the maximum total product.
4) When it becomes less than zero, total product declines.
5) When elasticity of product is 1.0 marginal and average products are equal.

A production function for which the elasticity is less than 1.0 throughout all ranges of input used will indicate diminishing returns.

4. Three Regions of Production Function

The 'classic' production function can be divided into three "parts" "stages", "regions" or "zones" each important from the stand point of decision making on efficient resource use. Input output relationships showing total, average and marginal productivity can be divided into three regions in such a manner that one can locate the portion of the production function in which production decisions are rational.

4.1. Region - I:

This region hold from the point of origin up to the point the MPP remains greater than APP, the APP increases throughout this region indicating that the efficiency of all the units of variable input keeps increasing. As soon as MPP equals APP, it is the end point of first zone.

4.2. Region – II:

This region obtains when MPP is decreasing and is less than APP. In this region of the standing point MPP is equal to APP and it extends to the point where MPP becomes zero.

4.3. Region – III:

This region obtains where MPP crosses zero point and becomes negative. Negative MPP occurs when so much excessive quantity of the variable input is used that total output begins to decrease.

5. Three regions of production functions & economic decisions

If the technical relationship between input and output is known, some broad recommendations about input use can be made, over without the knowledge of prices. Such decisions are discussed below.

5.1. Region – I:

Once the farmer decides to produce, he must produce up to the level of input use where the APP is the highest. In other words if the product has a value, input use once it gives profits should be continued until stage II is reached, because the efficiency of the variable input keeps increasing throughout the region 1. It is not reasonable to stop using an input when its efficiency on all units used is increasing. In this region, average product keeps increasing and MP remains greater than the AP. If it is profitable to produce any output at all, it will always be profitable for the producer to add inputs as long as the average product keeps increasing. In other words, if a producer is interested in maximizing his returns and if production is even profitable, it will always pay him to go atleast to the point of highest average product in the application of inputs.

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We have seen from the above discussion that Region – I and Region – III set the limits to the regions in which it is profitable or economically rational to operate. Therefore, Region – II is the region of rational decisions on resource use.

5.2. Region – II

In the Region – II, the total product is increasing. The marginal product keeps decreasing, but remains positive and less than the average product. The AP is also decreasing.

Within the boundaries of this region is the area of economic relevance. Optimum point of input use must be somewhere in this rational region. The optimum point can, however, be located only when input and output prices are known. It needs to be emphasized that this region of rational production embodies diminishing returns phase. Both average and marginal products are decreasing in this region.

This discussion thus leads us to the point that the producers who want to maximize their profits must operate in Region – II of the physical production function. In order to determine at what level in Region – II one should operate, one needs to know the product as well as input prices multiplying the quantities of product and inputs with the respective prices we can convert the physical production function into revenue and cost functions. The optimum level of input use will be where the additional cost of input is equal to the additional revenue which the input yields.

5.3. Region – III:

In the third region of the production function, the total product is decreasing and the MPP is negative. Since the additional quantities of input reduce the total output in this region, it is not profitable zone even

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if the additional quantities of the resources are available free of cost. It is therefore called as irrational zone of production, e.g., if a farmer operates in this region, it will be irrational because he will incur loss i.e., 1) reduced production and 2) unnecessary additional costs of inputs. There are several cases observed, where farmers have been seen operating in third region: On wheat Kalyan - 227 unnecessary heavy doses of fertilizer application by many farmers in the year 1967-68 resulted in lodging and this reduced yields. Another example is of excessive irrigation, often given by the farmers, resulting in reduction of yield. Similarly heavy feeding schedules of animals have also been observed.

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Course Name	Farm Management, Production & Resource Economics
Lesson 5	Factor – Factor or Input – Input Relationship
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Objectives

1. To learn how to produce the given level of output by substituting the factors.
2. To understand the yardsticks of least cost combination of inputs.

Glossary

Factor-Factor: Combination of two inputs.

Substitutes: Change in priceof X_1 leads to change in demand of X_2

Rate of substitution: It is the rate of exchange between two productive resources.

Complements: Resources which are used together in the production process are called complements.

Factor – Factor Relationship

In factor – product relationship, we studied the situation where only one input is varied and all other variables are held constant. But in most real world situations, two or more inputs are often varied simultaneously. So a farmer must choose the particular combination of inputs which would minimize the cost for a given output level. Thus, the main objective of this is minimization of cost at a given level of output.

When two or more inputs are varied, a given amount of output may be produced in more than one way, i.e. there is a possibility of substitution of one factor (X_1), for another (X_2) as product level (Y) is held constant.

The objectives of factor – factor relationship are

(i) minimization of cost at a given level of output and

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(ii) Optimization of output to the fixed factors through alternative resource use combinations. In this case, the production function is given by

$Y = (X_1, X_2 / X_3, \ldots\ldots\ldots\ldots\ldots\ldots X_n)$, i.e. the production depends on the amounts of X_1& X_2while the other inputs are held constant.

The factor – factor relationship deals with two independent variables and dependent variable giving rise to three-dimensional diagram. Isoquant is a convenient method of compressing three-dimensional diagram into two dimensional.

1. Concept of Isoquant or Isoproduct curve

An isoquant is defined as the locus of all combinations of inputs, X_1 and X_2 for obtaining a given level of output, say $Y^{(0)}$.

Iso means equal and quant is quantity. Iso-quant is also termed as iso-product curve or equal product curve or product indifference curve.

Isoquant is defined as the curve representing all combinations of X_1& X_2 that produce the same level of output is called as isoquant.

1.1 Properties of Iso-quants

1.1.1. **Isoquants slope downwards from left to right: If the quantities of input say X_1 is** increased, the quantity of other input say X_2 must be decreased to obtain the same level of output.

1.1.2. **Isoquants are convex to origin:** The absolute slope of isoquant decreases as we move left downwards to the right indicating diminishing rate of technical Substitution. Because of diminishing marginal rate of technical substitution, each added unit of one input replaces less and less than the previous unit.

1.1.3. **Isoquants placed above of another represent higher output:**Isoquants placed for higher level of output normally lie

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above the isoquants representing lower level of output. Alternatively, isoquants representing higher levels of output are placed farther away from the origin.

1.1.4. **Isoquants are non-intersecting :**No two isoquants intersects each other because the same combination of two input factors cannot produce two different levels of output.

2. Marginal Rate of Technical Substitution (MRTS)

It is the rate of exchange between two producer resources, which are equally preferred. It indicates the absolute amount by which productive resource is decreased to gain a unit of another productive resource. Alternatively, the quantity of one input to be sacrificed or given up in order to gain another input by one unit, in the process of substitution. MRTS of X_1 for X_2 is written as

$$MRTSx1x2 = \frac{\Delta X2}{\Delta X1} = \frac{\text{Quantity of input sacrificed}}{\text{Quantity of input gained}}$$

Table 1. Determination of MRTS of X_1 for X_2 for an output level of 100 units.

Units of X_1	**X_2**	**ΔX_1**	**ΔX_2**	**MRS of X_1 for X_2**
1	16	-	-	-
2	12	1	-4	-4
3	9	1	-3	-3
4	7	1	-2	-2
5	6	1	-1	-1
6	5.5	1	-0.5	-0.5

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The resources that are used by the farmers in production activity are either substitutes or complements.

2.1. **Substitutes:** Two resources are said to be substitutes, when change in the price of one leads to change in the demand for another.The substitutes are the range of input combinations that produce a given a level of output. Decrease in the amount of one input is compensated by an increase in the amount of other input, when resources are substitutes. The MRTS is negative.

2.2. **Perfect substitutes :**When the two inputs are completely interchangeable, then they are called perfect substitutes. Eg. : Family labour and hired labour, owned bullock labour and hired, farm produced and purchased input in this case isoquants are linear and negative sloped.

2.3. **Complements:** Resources which are used together in the production process are called complements. Two resources viz X_1 and X_2 are said to be complements, when the price of X_1 increases the demand for X_2 decreases. Decreases in the amount of one cannot be compensated by increasing the amount of another. The MRTS is zero.

2.4. **Perfect complements:** Resources which are used together in fixed proportions are called perfect complements. When inputs are perfect complements, the isoquants are 'L' shaped e.g., Tractor and driver, a pair of bullocks and human labour etc.

3. Types of factor substitution

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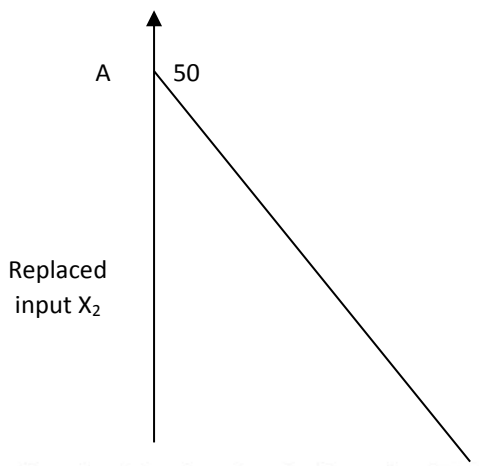
The slope of iso-quant depends upon the manner in which resources will be combined as fairly similar and dissimilar inputs are substituted in the production process.

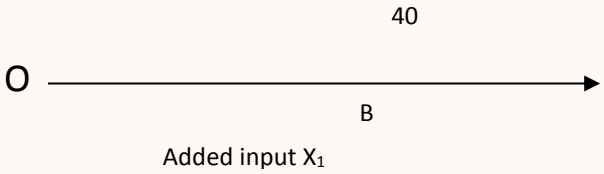
3.1. **Fixed proportion combination of inputs:** As the very nature of combination of inputs infers that a given level of output can be produced using the inputs in a fixed proportion. As such there is no problem regarding decision-making because there are no alternatives as far as the combination of input factors is concerned. There is only one way of combining the input factors.

4. Iso-Cost line

It is known as price line or iso - outlay line or budget line. Iso cost line represents various combinations of two inputs that can be purchased with the given outlay of funds.

The iso – cost line can be drawn by locating the end points of X_1 and X_2 given the total outlay and the prices per unit of X_1 and X_2. Suppose a farmer has a fund of Rs. 400 and he has to spend on two inputs viz., X_1 and X_2. The price per unit of X_1 is Rs. 10 and that of X2 is Rs. 8. Given the prices of X_1& X_2, he can purchase 40 units of X_1 or 50 units of X_2. When the entire amount of Rs. 400 is spent on X_1 the quantity that can be purchased is OB (40 units) and similarly the quantity of X_2 that can be purchased for Rs. 400 is OA (50 units). If points A & B are joined we get iso-cost line. For any combinations of X1 & X2 on iso-cost line, the total cost remains the same.





4.1. Characteristics of iso-cost line

There are two important characteristics of iso-cost line one its distance from the origin and another one is slope. When the total outlay or budget increases, the iso-cost line shifts upwards to the right. Alternatively, the iso-cost line moves farther away from the origin. The slope of the iso-cost line shows the increase price ratio of factors. Changes in the input prices change the slope of the iso-cost line. An increase in price of an input means less of that can be purchased if the price falls iso-cost lines are parallel to one another since the relative price ratio remains constant.

5. Least – cost combination

Factor – factor analysis is mainly concerned with the determination of least cost combination of resources. There will be many combinations of two resources that produce the same level of output. The problem here is to find out that particular combination of inputs, which produces a given quantity of output with minimum cost. Different methods of finding out the least-cost combinations

1) Tabular 2) Algebraic 3) Graphic method

5.1. Tabular method

This method can be used when there are few combinations. Given the input combinations and the prices of inputs, the total cost of

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each input combination can be computed. The combination which costs the least is selected.

Least cost combination of inputs (Tabular Method)

X_1 (units)	X_2 (units)	X_1 @ Rs. 4.00	X_2 @ Rs. 2.00	Total amount
50	219	200	438	638
55	206	220	412	632
60	194	240	388	628
65	182	260	364	624
70	171	280	342	622

The combination of 70 units of X_1 and 171 units of X_2 is the least cost combinations.

5.2. Algebraic Method

Step 1 : Compute marginal rate of technical substitution

$$\text{MRTS} = \frac{\text{No. of units of replaced resource}}{\text{No. of units of added resource}}$$

$$\text{MRTS}_{X1\,X2} = \frac{\Delta X2}{\Delta X1}$$ (When we substitute X_1 for X_2)

$$\text{MRTS}_{X2\,X1} = \frac{\Delta X1}{\Delta X2}$$ (When we substitute X_2 for X_1)

Step 2: Compute the inverse price ratio (PR)

$$\text{PR} = \frac{Price\ per\ unit\ of\ added\ resource}{\text{Price per unit of replaced resource}}$$

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Step 3: Finding the least cost combination by equating MRTS with inverse price ratio

$$\frac{\Delta X2}{\Delta X1} = \frac{PX1}{PX2} \; 0r \frac{\Delta X1}{\Delta X2} = \frac{PX2}{PX1}$$

$$\frac{PX1}{PX2} = \frac{4}{2}$$

Table 2: Least Cost Combination (Algebraic method)

X_1	X_2	ΔX_1	ΔX_2	$\Delta X_1/\Delta X_2$	PX_1/PX_2
50	219	-	-	-	-
55	206	5	-13	2.6	2
60	194	5	-12	2.4	2
65	182	5	-12	2.4	2
70	171	5	-11	2.2	2

$\frac{\Delta X_2}{\Delta X_1} = \frac{PX_1}{PX_2}$ $\frac{X_1}{X_2} = \frac{PX_2}{X_1}$

$\Delta X_2 \, PX_2 = \Delta X_1 \, PX_1$

If at any point on the isoquant $PX_2 \times \Delta X_2$ is greater than $PX_1 \times \Delta X_1$ then the cost of producing the given output could be reduced by increasing the use of X_1 and decreasing X_2 because the cost of added unit of X_2 is less than the cost of replaced unit of X_1. On the other hand, if at any point on the isoquant, $PX_2 \times \Delta X_2$ is less than $PX_1 \times \Delta X_1$ the cost of producing the specified quantity of output can be reduced by using less of X_1 and more of X_2. This equality criterion signifies that any change in the

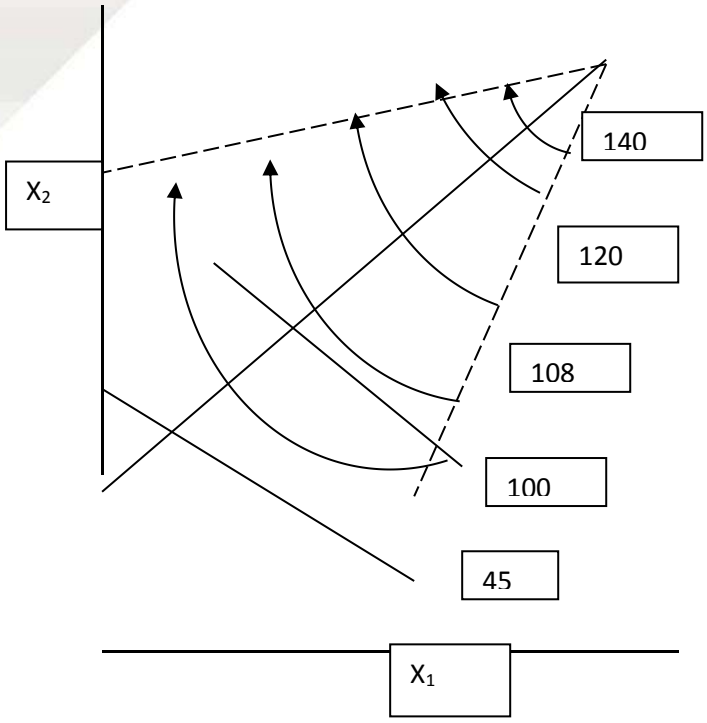
input combination from this point would increase cost of producing the output.

5.3. Graphic method

To find out the optimum combination of resources, through graphic method, both iso-quant and iso-cost line are drawn on the same graph. The slope of the isoquant indicates the rate of exchangeability (MRTS) between two resources, whereas the slope of isocost line represents the inverse price ratio of inputs (PR). The point of tangency between isoquant and isocost line indicates the least cost combination. At the point of tangency slope of iso-quant equals the slope of iso-cost line. Alternatively MRTS is equated with PR.

6. Isocline

There can be a number of possible output levels as shown in figure of isoquant map and least cost can be found out for these various output levels. A line or curve connecting the least cost combinations of input for all output levels is known as isoclines. This isocline passes through all the Isoquants at points where they have same slope.



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Suppose the inputs can be supplied in divisible units. Given the iso-product contours and slope of iso-cost lines, the minimum cost for each output is represented by their tangency points. A line passing through these least cost combination points will show how the relative proportion of the factors changes as output is increased. This line or isocline shows that resources should be used along with this line as long as the marginal value of the product is greater than the marginal cost of the resources used. Isoclines can be drawn at different sets of price ratios. Here for the sake of clarity, only two additional isoclines have been drawn and corresponding isocost lines have been omitted to avoid confusion. The price of X_1 drops relative to the price of X_2, increasing amounts of X_2 are included in the least cost combinations. All isoclines, of course, converge at the point of maximum output if the maximum exists.

7. Expansion path :

As has been explained earlier, there can be numerous isoclines for different 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 which he may think to be the most appropriate for the planning period. The isocline dependent upon this set of prices is called "expansion path" of many isoclines, the isocline which is considered to be most appropriate over a production period is known as expansion path. At any particular time, only one expansion path is possible.

8. Ridgelines (Boundary lines) :-

Ridgelines represent the points of maximum output from each input, given a fixed amount of the other input. For example, in the previous figure the dashed lines represent special type of isoclines called ridgelines. As an example when X_1=1, output can be increased by adding X_2 up to 7 units as denoted on the ridge line. At that point, output from $X_2$is

maximum given one unit of X_1. Here MPP of X_2 will be zero, past X_2 =7, MPP will be negative. The ridge lines denote the limits of substitution. These lines represent the limits of economic relevance, the boundaries beyond which isocline and isoquant maps cease to have any economic meanings.

9. Isocline and Expansion path

Isocline is the line or curve that passes through the points of equal marginal rates of substitution on an isoquant map. That is, a particular Isocline will pass through all isoquants at points where the isoquants have specified slopes there are as many different isoclines as there are different slopes or marginal rates of substitution on an isoquant. The expansion path is also an isocline that connects the least cost combination of inputs for all yield levels. On an expansion path the marginal rate of substitution must equal the inverse price ratio.

Expansion path ($MRS_{X_2 X_1}$) = $\frac{\Delta X1}{\Delta X2} = \frac{PX2}{PX1}$

Ridge lines represent the limits of the economicrelevance, the boundaries beyond which the Isocline and Isoquant maps have no economic meaning. The horizontal ridge line represent where MPP_{X1} is zero and the vertical line represents the points where MPP_{X2} is zero.

Ridge line for X1 → $\frac{\Delta X2}{\Delta X1} = 0$, $\frac{\text{MPP X1}}{\text{MPP X2}} = r = \frac{0}{\text{MPP X2}}$

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Objectives

1. To understand the .basic production relationships
2. To identify the combination of products to maximize the profit.

Glossary

Product-Product: Combination of two products.

Product: A product can be a service or an item.

Rate of product substitution: It is the rate of exchange between two products.

Operational holding: It is the total land area held under a single management for the purpose of cultivation. It excludes any land leased out to another person but it includes any land leased in from another person.

Product-Product Relationship

The farmers are faced with the management problem of what to produce? Farmers have to decide whether to decide crop alone or livestock alone or their combinations of crop and livestock enterprises that maximizes profit.

In this chapter a different view of the production process is taken. Instead of considering the allocation of inputs to an enterprise or among enterprises, we discuss enterprise combinations or product mix involving product - product relationships. Algebraically the relationship can be written as

$Y_2 = f(Y_1)$

or

$Y_1 = f(Y_2, Y_3, Y_4.....Y_n)$

This expression reveals that a farmer is having an option of growing few or more crops in the same season in his operational holding.

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Suppose a farmer has 10 acres of land and he wants to grow wheat along with other competitive crops like gram, barley, sugarcane, fodders, etc., In this case, acreage under wheat will be a function of acreage under gram, barley, sugarcane and fodders.

Production possibility curve (PPC)

The possibility of producing different products with a limited resource can be studied through PPC. The production possibility curve can be derived from production functions.

Suppose a farmer has limited input i.e 4 acres of land (Table 1). He has two alterations i.e. the production of Y_1 product and Y_2 product. The problem here is as to how to allocate this limited input between two alternatives. The alternatives are using the entire 4 acres of land for the production of Y_1 alone or allotting 4 acres of land for production of Y_2 alone. In between these two extreme possibilities, we have different options like possible production levels form the given acreage of land.

Table 1: Allocation of limited amount of land among two products

Area allotted between two products (Acres)		Output	
Y_1	Y_2	Y_1	Y_2
0	4	0	300
1	3	100	250
2	2	150	190
3	1	200	100
4	0	250	0

Allocation of 1 acre for Y_1 and 3 acres for Y_2, two acres for Y_1 and two acres for Y_2, 3 acres for Y_1 and 1 acre for Y_2, 4 acres for Y_1 and Y_2 attained zero. Suppose a farmer wants to produce some quantity of Y_1, he has to withdraw some area of land from the production of Y_2. If one acre

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is allotted to Y_1, he will obtain 100 units of Y_1 and remaining three acres of land yield him 250 units, like wise 2 acres of land under Y_1 and 2 acres of land under Y_2 would yield an output of 150 and 190 units respectively. Other possibilities can be seen from the Table 1.

The different levels of land input and the corresponding levels of output of Y_1& Y_2 represent two production functions. Production Possibility Curve (PPC) is a convenient method of depicting two production functions as a single graph.

Production possibility curve represents all possible combinations (Fig. 1) of two products (Y_1 & Y_2) that could be produced with given amount of resources.

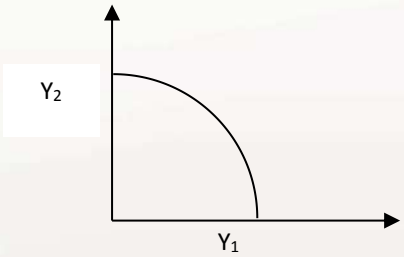

Fig.1. Production Possibility Curve (PPC)

PPC is also known as iso-resource curve or iso-factor curve, since all the combinations oftwo products require the same amount of resources. The PPC represents the producer about the production opportunities available with a given amount of resources and hence it is called as opportunity curve. The slope of the production possibility curve indicates the trade-off between the two products. It indicates the rate at which one product is transformed into another product. Therefore, it is called transformation curve. It is also a frontier because the limited resources cannot help to produce anything beyond production possibility curve. It demonstrates what is possible to produce with the available quantity of inputs. The area under the production possibility curve including the axes is called the feasible set or the attainable set of outputs.

Characteristics of PPC

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1) It is concave to the origin
2) Slope of PPC indicates the marginal rate of product substitution
3) Change in input levels shifts the PPC

Basic relationships among the products

The basic product relationships that exist are joint products, complementary, supplementary and competitiveness

Joint products

Products which are produced from the same production process are called joint products. The two products derived through the production process are combined in fixed proportions. Production of one without the other is not possible. In agriculture, almost all the products are joint products. The proportion of the joint products can be altered or manipulated through researchbreakthrough in the long run.

Eg. : Paddy and straw, cotton lint and seed, meat and wool, *jowar* and straw.

Production possibility curve for joint products can be seen as a point for a given quantity of resources (Fig. 2). The different points indicate various levels of resources available.

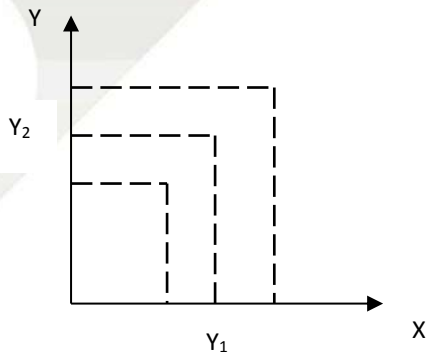

Fig.2. PPC for joint products

Complementary products

The products are complementary, if an increase in one product causes an increase in the other product, when the total quantity of inputs used on the two products are held constant. Similarly, a decrease in the

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production of one product results in the decrease in the production of other product. They do not compete for the resources. One of the products contributes an element of production required by another thereby helping each other in production (Fig. 3), for instance,rice succeeding a legume crop, the legume fixes nitrogen thereby improving the soil fertility for the next crop.

Similarly, paddy and livestock are complementary as paddy crop provides straw to livestock and livestock in turn makes the availability of farm yard manure to the paddy crop. Hence, these two contributes to their production. The complementary products would become competitive, when large quantities of resources are diverted to one production affecting the production of the other. The MRPS is positive.

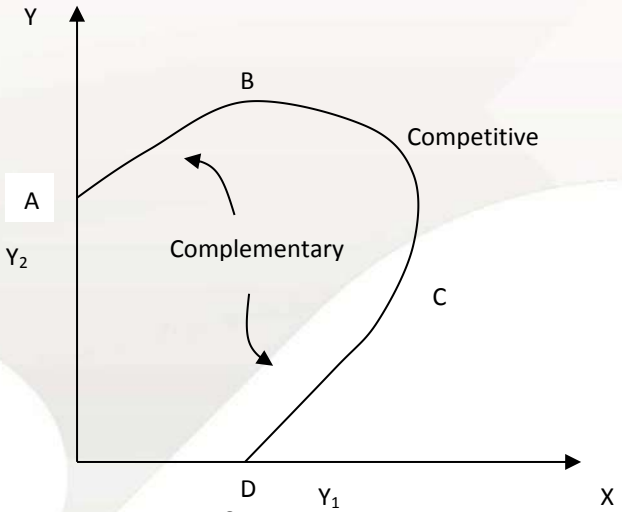

Fig.3. PPC for Complementary products

As can be seen from the figure that Y_1 is complementary to Y_2 between A & B, whereas Y_2 is complementary to Y_1 between C and D, between the points B and C, the two products become competitive. Farmers can take the advantage of complementary by producing both the products till they become competitive.

Supplementary products

Two products become supplementary, if the quantity of one product can be increased without increasing or decreasing the quantity of

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the other product. They do not compete for the resources. Instead they make better utilization of resources, which are being unutilized by one enterprise. They together add to the income on the farm. Crop production is seasonal in nature and during off season the resources are slack. They can be better utilized by adding supplementary enterprises viz., a small dairy unit or poultry unit or piggery unit. A farmer should take best advantage of the products by producing both of them till they become competitive. The marginal rate of product substitution is zero.

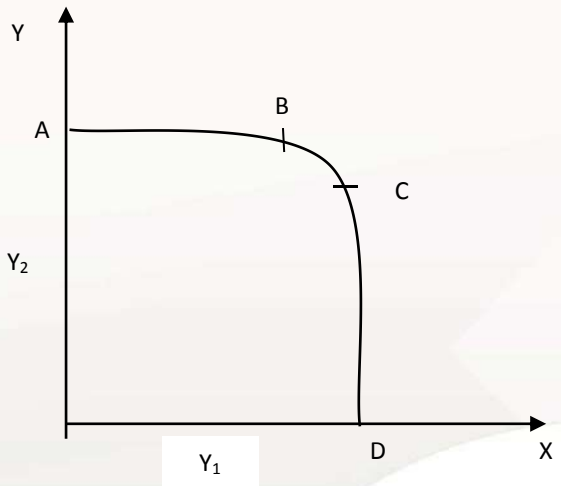

Fig. 4 Supplementary Enterprises

Production possibility curve for supplementary enterprises is shown in fig 4. The product Y_1 can be increased upto AB without affecting the production of Y_2. If it is further increased the two products will become competitive. It can be seen in the diagram that the two products are competitive between the points B and C.

Competitive products

Two products are said to be competitive, when increase or decrease in the level of production of one results in decrease or increase in the level of production of another, given the fixed amount of resources (Fig. 5). The marginal rate of product substitution between the products is therefore, negative. Most of the decisions regarding the selection of products involve competing products. The examples are paddy and sugarcane, paddy and groundnut, groundnut and sunflower, etc. In

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general, crops grown in the same season are competitive because of limited resources.

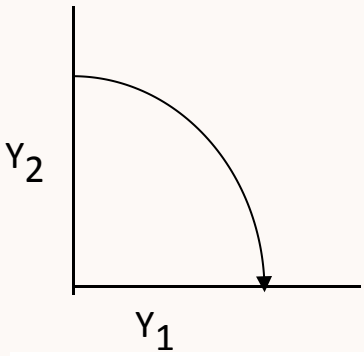

Fig. 5 Competitive Enterprises

Antagonistic products

The presence of one enterprise affects relations of another enterprise e.g., paddy cultivation and aquaculture

Marginal rate of product substitution

The marginal rate of product substitution means the rate of change in quantity of one output as a result of unit increase in the other output, given that the amount of the input used remains constant.

Marginal rate of product substitution (MRPS) of Y_1 for Y_2 will be :

$$\text{MRPS}_{Y1\,Y2} = \frac{Y_2}{Y_1}$$

MRPS Y_1 for Y_2 implies that the amount of Y_2 to be given up in order to gain Y_1 by one unit. When two products are competitive, they may substitute at constant rate, increasing rate or decreasing rate.

Constant rate of substitution

Two products substitute at constant rate when a unit increase in the production of one replaces the same amount of another product throughout the process of substitution. In other words, a constant

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amount of replaced product is replaced in order to gain added product by one unit. Constant rate of substitution occurs when one of the production functions has elasticity greater than one (increasing returns), the other has an elasticity of less than one or both Y_1 and Y_2 production functions have stages of both increasing and decreasing returns. The production possibility curve is linear when products substitute at constant rate the production of only one product is economical based on the relative prices of the two products. This is a case of specialization. The example here is two varieties of the same farm commodity.

The relevant data are presented in the Table 2. When we shift from A combination to B combination, Y is increased by one unit and Y_2 is decreased by 6 units and MRPS is 6 i.e., we need to reduce 6 units of Y_2 to increase Y_1 by one unit. Similarly, when we shift from combination B to C, C to D, D to E and E to F the amount of Y_2 to be given up is same (Fig. 6).

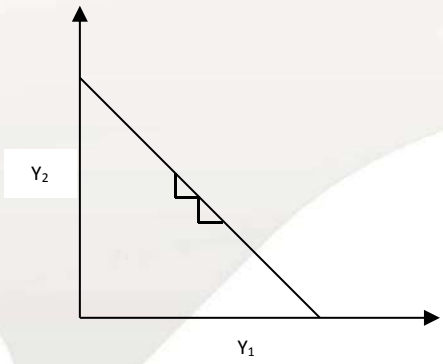

Fig. 6. Constant rate of product substitution

Table 2: Two competitive products substitute of a constant rate

Combinations	Y_1	Y_2	ΔY_1	ΔY_2	MRPS Y_1 for Y_2
A	0	60	-	-	6/1=6
B	1	54	1	6	6/1=6
C	2	48	1	6	6/1=6
D	3	42	1	6	6/1=6

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E	4	36	1	6	6/1=6
F	5	30	1	6	6/1=6

$$\frac{Y_2\ A}{Y_1 A} = \frac{Y_2\ B}{Y_1 B} = \frac{Y_3\ C}{Y_1 C} = \ldots\ldots = \frac{Y_{2n}}{Y_1 n}$$

Increasing rate of substitution

Two products substitute at increasing rate when increase in one product requires larger and larger sacrifice in terms of another product. This type of substitution occurs when the production function of each independent product exhibits decreasing returns substitution. This nature is more common in agril. production, as the diminishing marginal resource productivity is a general feature in agriculture. Production possibility curve is concave to the origin when products substitute at increasing rate. The exampleof this is all the crops grown in the same season viz., paddy and sugarcane, groundnut and sunflower, paddy and groundnut etc. When products substitute at increasing rate, it is economical to produce a combination of products. The general pattern of production is diversification. A hypothetical example of increasing product substitution is presented in Table 3.

Table 3.Two competitive products substituting at increasing rate

Combinations	Y_1	Y_2	ΔY_1	ΔY_2	MRS of Y_1 for Y_2
A	0	75	-	-	-
B	8	60	8	15	1.88
C	16	44	8	16	2.00
D	24	26	8	18	2.25
E	32	0	8	26	3.25

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$$\frac{\Delta Y_{21}}{\Delta Y_{11}} < \frac{\Delta Y_{22}}{\Delta Y_{12}} < \frac{\Delta Y_{23}}{\Delta Y_{13}} < \ldots\ldots < \frac{\Delta Y_{2n}}{\Delta Y_{1}n}$$

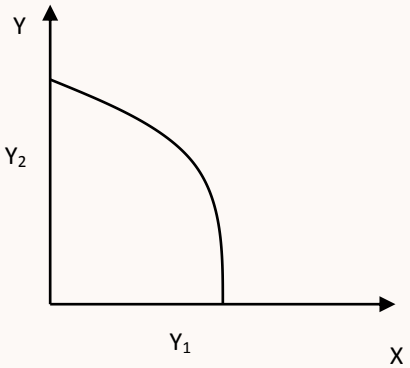

Fig. 7.Increasing rate of product substitution

Shifting from combinations A to B, results in increase in Y_1 by 8 units and decrease in Y_2 by 15 units MRPS is 1.88. It means 1.88 units of Y_2 are to be sacrificed to gain Y_1 by one unit. When we shift from B to C, C to D, and D to E the amount of Y_2 to be foregone is successively increasing as indicated by the increasing MRPS (Fig 7).

Decreasing rate of substitution

The products substitute at decreasing rate when increase in one product requires lesser and lesser reduction in another product. This type of substitution is observed when the production functions of both the products exhibit increasing returns. This type of substitution is very rare in production process, because increasing returns are seen in I stage of production which is irrational. It is economical to produce only one of the products depending upon the relative prices of the products. The general pattern of production is specialization. The production possibility curve is convex to the origin. A hypothetical example is given below:

Table 4.Two competitive products substituting at decreasing rate.

Combination	Y_1	Y_2	ΔY_1	ΔY_2	MRS of Y_1 for Y_2
A	0	43	-	-	-
B	2	27	2	16	8
C	4	15	2	12	6
D	6	6	2	9	4.5
E	8	0	2	6	3.0

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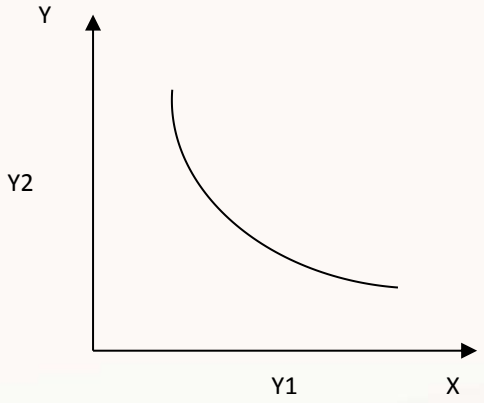

Shifting from combination A to B results in increase in Y_1 by 2 units and decrease in Y_2 by 16 units. It means 8 units of Y_2 are to be sacrificed to gain Y_1 by one unit. When we shift from B to C, C to D and D to E, the amount of Y_2 to be forgone is successively decreasing as indicated by the decrease in MRPS.

Fig 8.Decreasing rate of product substitution

$$\frac{\Delta Y_{21}}{\Delta Y_{11}} > \frac{\Delta Y_{22}}{\Delta Y_{12}} > \frac{\Delta Y_{23}}{\Delta Y_{13}} > \ldots\ldots < \frac{\Delta Y_{2n}}{\Delta Y_{1}n}$$

Iso- Revenue line: It is a line, which defines all possible combinations of two products, which would yield equal revenue.

Suppose we wish to obtain total revenue of Rs. 20,000, when the price of cotton (Y_1) is Rs. 2000/- per quintal and of maize is Rs. 1000/q. The expected revenue of Rs. 20,000 could be earned by producing 10 qtls of cotton (Y_1) or 20 units of Maize (Y_2). There can be many other combinations of Y_1 and Y_2 which may give the same total revenue of Rs. 20,000. These points when graphed will make a straight line called an iso-revenue line as shown in the below Fig.9.

Characteristics of iso-revenue line

1) Iso-revenue line is a straight line as the output prices do not change with the quantity of output sold.

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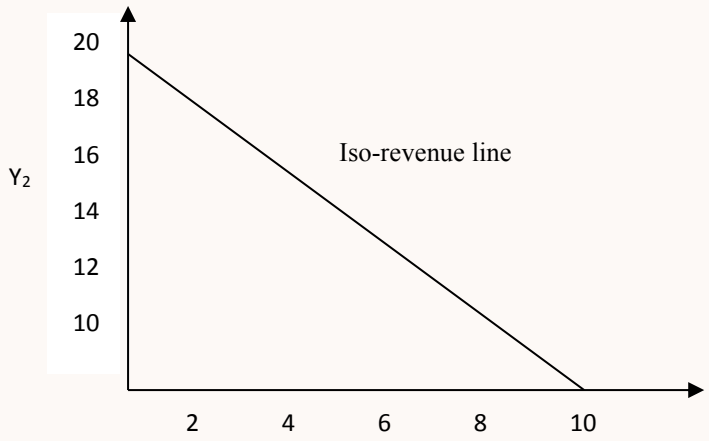

Fig 9.Iso-revenue line

2) As the total revenue increases shifts upward and moves away from the origin (Fig. 10)

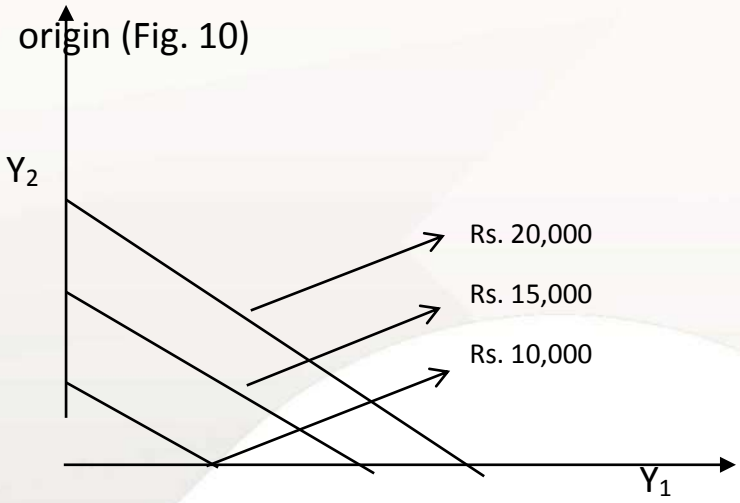

Fig 10.Shift in Iso-revenue line

3) The iso-revenue lines are parallel to each other since price ratio remains constant
4) The slope of the iso-revenue line indicates the inverse price ratio of the products. The slope is affected by price changes (Fig. 11)

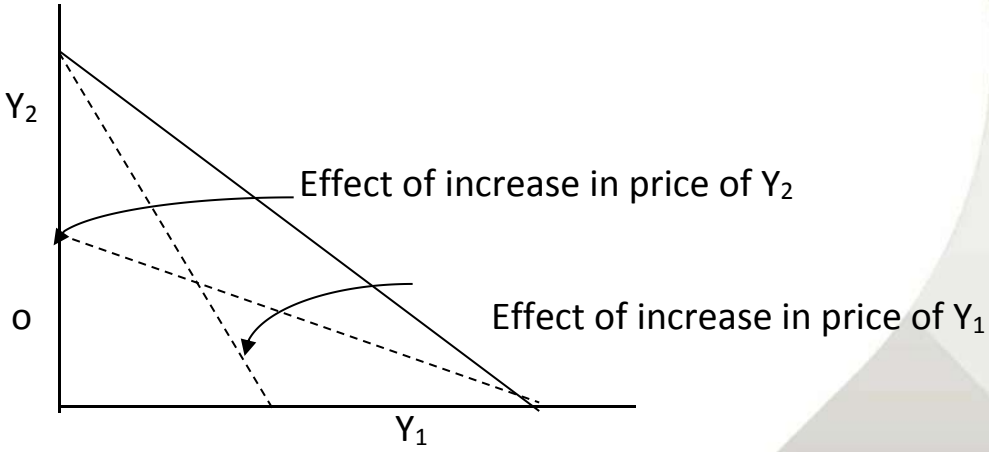

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Fig 11. Change in slope of Iso-revenue line

An increase in the price of Y_1 shifts the intersection of the iso-revenue line with the Y_1 axis closer to the origin. A decrease in the price of Y_1 shifts the intersection of the iso-revenue line farther from the origin on the Y_1 axis. Similar changes are evidenced on the Y_2 axis in response to changes in the price of Y_2.

Determination of optimum product combination

To get the revenue maximizing combination of two products two relevant questions arise

1) What combinations should be produced? and
2) How can that combination be determined?

To answer these questions, the following methods need to be examined.

Tabular method:

Given the output combinations and prices, the total revenue of each output combination is computed and the combination which yields maximum revenue is selected. In the example given below, the combination of 16 quintals of cotton and 6 quintals of paddy gives the maximum income of Rs. 38,000 (Table 5)

Table 5.Determination of optimum product combination

Cotton (Y_1)	Paddy (Y_2)	P Y_1 @ Rs. 2000	PY_2 @ Rs. 1000	Total income
0	20	-	20,000	20,000
8	14	16,000	14,000	30,000
10	11	20,000	11,000	31,000
16	6	32,000	6000	38,000
18	0	36,000	0	36,000

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Algebraic method

Step 1: Compute MRPS between products

$$\text{MRPS } Y_1 \text{ for } Y_2 = \frac{\Delta Y_2}{\Delta Y_1}$$

Hence Y_1 is replacing (added) product and Y_2 is replaced product

$$\text{MRPS } Y_2 \text{ for } Y_1 = \frac{\Delta Y_1}{\Delta Y_2}$$

Hence Y_2 is replacing product and Step 2, compute price ratio

Step 2: $$\text{Inverse PR} = \frac{\text{Price per unit of added product}}{\text{Price per unit of replaced product}}$$

$$Inverse\ PR = \frac{PY_1}{PY_2}\ or\ \frac{PY_2}{PY_1}$$

Step 3: Finding out the combination of products by equating MRS with PR

$$\frac{\Delta Y_2}{\Delta Y_1} = \frac{PY_1}{PY_2}\ \boldsymbol{or}\ \frac{\Delta Y_1}{\Delta Y_2} = \frac{PY_2}{PY_1}$$

Graphic method

To determine the optimum combination of products through graphic method, PPC and Iso – revenue line are used. Slope of PPC indicates the MRS and that of Iso-revenue line represents the inverse price ratio of the products. The optimum combination products are at the point where the iso-revenue line is tangent to PPC. At the point of tangency the slope of PPC and iso-revenue line are the same (Fig. 12).

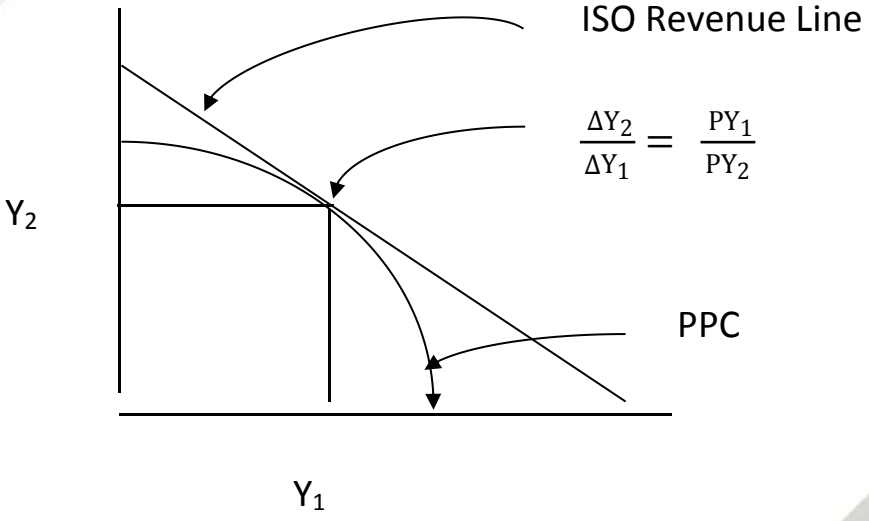

Fig 12.Optimum combination of products

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Ridge line and isocline for the PPC

Isoclines are the lines or curves that pass through the points of equal slope on a production possibility map. Ridge lines can be used to separate the range of product competition from ranges of complementarities. In the Figure 13, OA and OB are two side lines. These ridge lines are also called border lines. Line OA intersects PPC where they are horizontal and line OB intersects at the points where the curves go vertical. So, Ridge lines separate ranges of competition and product complementarity. In the below Figure 13, OA and OB are ridge lines, that portion of production possibility curves, falling between OA and OB have negative slope indicating the existence of competition between the products, while that portion of the production possibility curves falling outside OA and OB, have positive slopes indicating complementary along the path OA, the MRS of Y_1 for Y_2 is zero, while along the path OB, the MRS of Y_1 for Y_2 is zero.

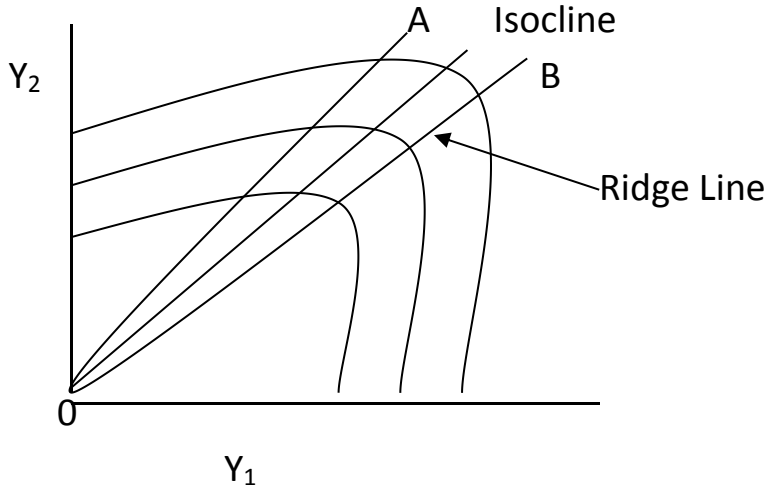

Figure 13. Ridge lines and Isocline

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Expansion path in product – product analysis

As in case of input combinations, there are iso-clines in output combinations analysis also. In the following fig. 14, several iso-revenue lines are shown each indicating a different level of revenue. Prices are assumed constant and the slope of the lines the same. All these iso-revenue lines are tangents to the production possibility curve at different points *viz*., m, o and p. The line connecting the equilibrium points (tangency of iso-revenue line with PPC) is the expansion path. The points of tangency specify the most profitable enterprise combination for different PPC with prices indicated by the iso-revenue lines. As one moves up the expansion path, total revenue increases but total costs also increase.

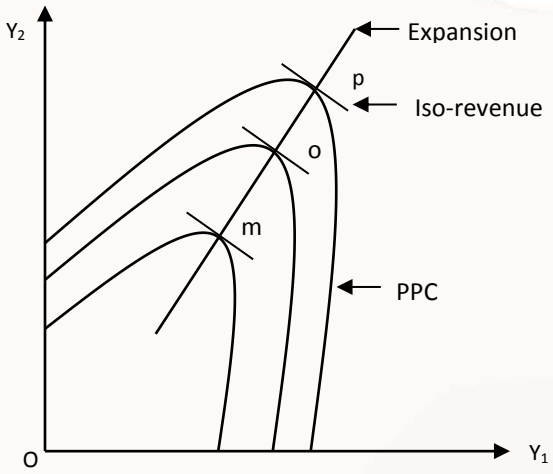

Fig. 14 Expansion path with iso-revenue

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Course Name	Farm Management, Production & Resource Economics
Lesson 7	Law of Equi-Marginal Returns
Content Creator Name	Dr G M Hiremath
University/College Name	University of Agricultural Sciences Raichur, Raichur
Course Reviewer Name	Dr. Dhruv Kishor Sinha
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Objectives

1. To understand the .allocation of resources under limited capital situation
2. To understand the absolute and relative advantages in the selection of enterprises

Glossary

Limited resources: Generally, the resources are limited in real situation.
Opportunity cost: The returns forgone in the next best alternatives.
Economic advantage: Are two types, relative and absolute advantage.
Specialization: Based on the resource endowment, certain regions get specialization in the production of certain crops.

1. **Principle of equimarginal returns**

Under the conditions of unlimited resources, the law of diminishing returns helps in determining the most profitable level of resources use. In really most of the resources like land, irrigation, capital, etc with most of the farmers are limited when the farmers are constrained by the resources, they must prudently decide as to how the available resources should be allocated among alternative uses to gain maximum income.

The principle of equimarginal returns provides guidelines and ensures that allocation of a limited input is done in such a way that profit is maximized from each unit of input. The law states that "The limited resources should be allocated among alternative uses in such a way that the marginal value product of the last unit of the resources is equal in all uses.

Any limited input should be allocated in that use where it brings in the greatest MVP. The limited availability of capital (hire Rs. 5000) must be allocated among the three crops viz., sugarcane cotton and paddy in the following manner based on MVPs. The first dose of Rs. 1000 has the potential of yielding of Rs. 2000, Rs. 3,200 and Rs. 2,200 from paddy, sugarcane and cotton, respectively. So the first dose of capital is invested on sugarcane, which brought in the maximum MVP among the

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alternatives. For the second and third dose of capital also, the sugarcane is highest yielding MVP, fourth for cotton and fifth for paddy are allocated. Any other allocation of capital among the crop enterprises other than the above will not help the farmer to obtain maximum returns.

Sl.No.	Amount of required capital	MVP for every Rs 1000		
		Paddy	Sugarcane	Cotton
1.	1000	2000	3200	2200
2.	2000	1400	3000	1800
3.	3000	1200	2500	1400
4.	4000	1100	1600	1000
5.	5000	1000	1200	800

This principle is also called as the law of opportunity cost, which is defined as: “the cost of using one resource in production of one product is the return that would have been received from the same resource used in its most profitable alternative use”.

The principle refers to the money returns or advantage which might have been obtained from any factor used in the production of a commodity, if it had not been used in producing that commodity; but could have been used for some other commodity.

The value of one enterprise is sacrificed as a cost in the production of another enterprise. In simple terms, it is the cost equivalent to the returns from the next best alternative foregone.

Practical Utility of the Law of Equi-marginal returns

a) It guides the farmer to plan his budget for the preparation of his cropping scheme and fitting there in his livestock programme.

b) It enables him to determine enterprise relationship-complementary or competitive

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c) It provides guidance to the adoption of diversified or specialized farming, as there is a profitable limit for each enterprises as well as most profitable enterprise.

2. Principle of Comparative Advantage

It is true that many crop and livestock enterprises can be raised over diversified soil types and climate conditions, but with differences in yields, costs and returns. This leads to specialization in the production of farm commodities by individual farmers or regions

Example:	Wheat	- UP, Punjab and Haryana
	Rice	- AP, WB, TN and Assam
	Cotton	- Maharashtra and TN
	Sericulture	- Karnataka
	Apple cultivation	- H P
	Sheep	- Rajasthan
	Poultry farming	-AP & TN
	Fresh water prawn culture	- AP and Orissa

Thus, regional production specialization in the production of crops and livestock enterprises is better explained by the principle of comparative advantage.

The relative yields, costs and returns are to be considered as the criteria for explaining the principle.

In the production of farm commodities there are two kinds of economic advantage.

1) Absolute advantage
2) Relative advantage or comparative advantage

The size of the margin between costs and returns of farm using the productive inputs represents the absolute advantage. If this margin is larger for one farm commodity in one region compared to another, we

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say that the first region has an absolute advantage in producing that commodity. This is illustrated with an example as below.

Absolute advantage

	REGION A		REGION B	
Particulars	**Groundnut**	**Sunflower**	**Groundnut**	**Sunflower**
Gross income (Rs. / Acre)	5000	5010	7300	2500
Total costs (Rs. / Acre)	4700	4320	6500	2450
Net income(Rs. / Acre)	300	690	800	50
Returns per rupee of Investment	1.06	1.16	1.12	1.02

Region 'A' has an absolute advantage in sunflower production because size of the margin between costs and returns is greater than that for region 'B'. Similarly, in region 'B' has an absolute advantage in groundnut production for the same reason.

Relative advantage

Particulars	**REGION A**		**REGION B**	
	Redgram	**Groundnut**	**Redgram**	**Groundnut**
Gross income (Rs. / Acre)	5600	7300	2300	3300
Total costs (Rs. / Acre)	5200	6500	2000	3100
Net income(Rs. / Acre)	400	800	300	250
Returns per rupee of Investment	1.08	1.12	1.15	1.06

Farmers in region 'B' or 'A' can make profit by growing both the crops. But in order to earn maximum profits, farmers in region 'B' should allocate larger acreage under groundnut alone as it is related to comparative advantages in growing both the crops but they have relative

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advantage in growing Redgram. The farmers can make greatest profits by cultivation Redgram as the percentage of returns on the cost of cultivation being 115 per cent for Redgram and 106 per cent for groundnut.

How does the Law direct the Farmer in Farming?

The law of comparative advantage directs a farmer in the selection of those crop and livestock enterprises, in the production of which available resources have the great relative and not absolute advantage. Thus fruit and vegetable farming near the cities, sugarcane farming around the sugar factories, paddy farming in the low-lying humid region and sheep farming in the hills are outcome of the operation of this principle. The specialised or diversified farming depends largely on the principle of comparative advantage.

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Course Name	Farm Management, Production & Resource Economics
Lesson 8	Cost Concepts, Types and Their Interrelationship
Content Creator Name	Dr G M Hiremath
University/College Name	University of Agricultural Sciences Raichur, Raichur
Course Reviewer Name	Dr. Dhruv Kishor Sinha
University/college Name	Dr. Rajendra Prasad Central Agricultural University, Samastipur

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Objectives

1. To give a thought to the concept of cost
2. To understand the types of cost and their interrelationship

Glossary

Poly-period resources: Which represent stock of services (transfer services) and only a part of these stocks of services is transformed into product in each distinct production period.

Monoperiod resources: Which also represents a stock of services (seed, fertilizer) but here entire stock of services is transformed into product in a single period.E,g., seeds, fertilizer

Cost of production: It is referred to the expenses incurred per unit of output.

Cost of cultivation: It is referred to the expenditure incurred per unit area.

1. Introduction

Production costs play an important role in the decisions of the farmers. Explicitly or implicitly most of the producers keep in mind the cost of producing additional units of output.

In general, at given level of prices, a farmer can increase his farm income in two ways i.e., (i) by increasing production and / or (ii) by reducing the cost of production.

In a competitive market, prices are not in the control of an individual farmer because there are large numbers of farmers who are individually producing very small proportions of total production of a commodity. His additional production must therefore, sell at the same or even lower prices, even though additional production must involve higher costs. The second alternative is to reduce the cost of production through rationalization of resource use with low cost production factors. Since

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cost minimization is an individual skill, degree of success in this direction, directly adds to the profits of the farmers.

Cost of production often becomes a policy issue when producers complain that the prices what they receive do not cover the cost of production. Hence there is need to have better understanding of various cost components to have control over resource use and manage different cultivation practices.

2. The concept of cost

The cost here refers to the total amount of funds used in production. These funds or cost out lays for productive services are directly related to the laws of production. The nature of production function and prices thus determine the cost structure. Cost of production exists because the supply of productive resources is scarce relative to their demand. These costs have relevance to a specific time period. The costs in any production period include the value of the resource services transformed into product in this single period rather than the value of the resources itself. The resources used in the production may be poly period or mono period resources.

In common usage the term “cost of production” is used in the sense of money costs or expense of production.

In economics, however, cost means the total efforts, sacrifices and exertion involved in the production of a commodity while expenses of production signify only money costs. So the cost of production involves both cash cost items and non cash items.

Cash costs: are incurred when resources are purchased and used immediately in the production process. For the most, cash costs result from purchases of non-durable inputs such as fertilizers, fuel oil, seeds, etc which do not last more than one production period.

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Non – cash costs: consists of depreciation and payments to resources owned by the farmers e.g., depreciation on tractor, equipments, buildings, payments made to the farmers himself or family labour, management and owned capital.

Planning period:

For proper understanding the process of decisions about costs, it is important to consider the planning period over which the decisions are made.

On the basis of length of period for different inputs to get transformed into products, planning period can be divided into two categories.

1) Short period or short run planning period
2) Long period or long run planning period

Short period: It is a period of time which is long enough to permit desired changes in output without altering or changing the size of the plant.

E.g.,increasing the production of milk by two ways one is by increasing the size of the plant i.e. number of cows or by changing the feed mix. In short run, it is not long enough to change the size of the plant.

Farmer has sown 10 acres of wheat in November with the expectation of a price at Rs. 800 per quintal. Further, suppose in February the expectation revise to Rs. 1000 per quintal. At this stage he cannot increase acreage under this crop. Alternative for him will be to add more fertilizer and get increased yields. This short period is not long enough to change size of the plant.

Long Period*:* The long period is generally the period which is sufficiently long enough for output level to be altered or changed by varying even the size of the plant.

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Suppose the same farmer expects that wheat production is going to be more remunerative in future years. He may try to increase land by purchasing or leasing in and improve the productive capacity by installing tube wells, etc. In other words, sufficient time period will be needed to change the size of the land holding. This time period is enough to allow the change in size of plant or holding is known as long period or long run period.

3. **Categories of cost**

Corresponding to two lengths of planning periods, there are two major categories of cost namely

(i) Fixed costs or sunk costs or supplementary costs
(ii) Variable costs or prime costs

A resource or input is called a fixed resource if its quantity cannot be varied during the production period. These costs do not vary with the level of output.

A resource is variable resource if its quantity can be varied during the production period. These costs vary with the level of enterprise/output.

In general, costs associated with fixed inputs are called fixed costs and costs associated with variable inputs are called variable costs.

3.1. Fixed costs

Fixed costs are those which do not change in magnitude as the amount of output of the production process changes and are incurred even when production is not undertaken. These are sunk costs. These costs can be cash or non-cash fixed costs.

Fixed cash costs include land taxes, interest, insurance premiums, annually hired labour, etc. Non-cash fixed costs include depreciation on buildings, machinery, equipment, interest on capital investment, cost of family labour and cost of management. It should be emphasized that

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costs do not become fixed until they have been incurred or committed. After these costs get incurred they do not vary with change in output and have no bearing upon decisions to increase or decrease production. In the very long run, however, all costs become variable.

3.2. Variable costs

Variable costs are the costs of using the variable inputs. These costs vary with the level of production. Higher the production more will be the variable costs. Lower the production, lower will be the variable costs. These costs include items such as fertilizers, insecticides, fuel consumption, etc.

3.3. Total cost:

Fixed cost plus variable costs equal total costs. Total costs are required for computing net revenue. Net revenue is equal to total revenue less total costs.

4. COST FUNCTION

As in the case of other functional relationships, the total cost curve or cost function represents the functional relationship between output and total cost. Here the discussions will relate to how costs are related to levels of output i.e., what will happen to cost structure when we produce different quantities of a commodity.

These cost functions or curves can also be presented in three ways

(i) Arithmetically (tabular form)
(ii) Geometrically (in graphic form) and
(iii) Algebraically (in equation form)

4.1.The total cost function

The exact nature (curvature) of the total cost function depends on the nature of the corresponding production function i.e. the shape of

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the total cost curve is determined by the production function, provided that the price which the producer pays for inputs does not change as the quantity of inputs purchased changes.

4.2. Relationship between production function and total cost function

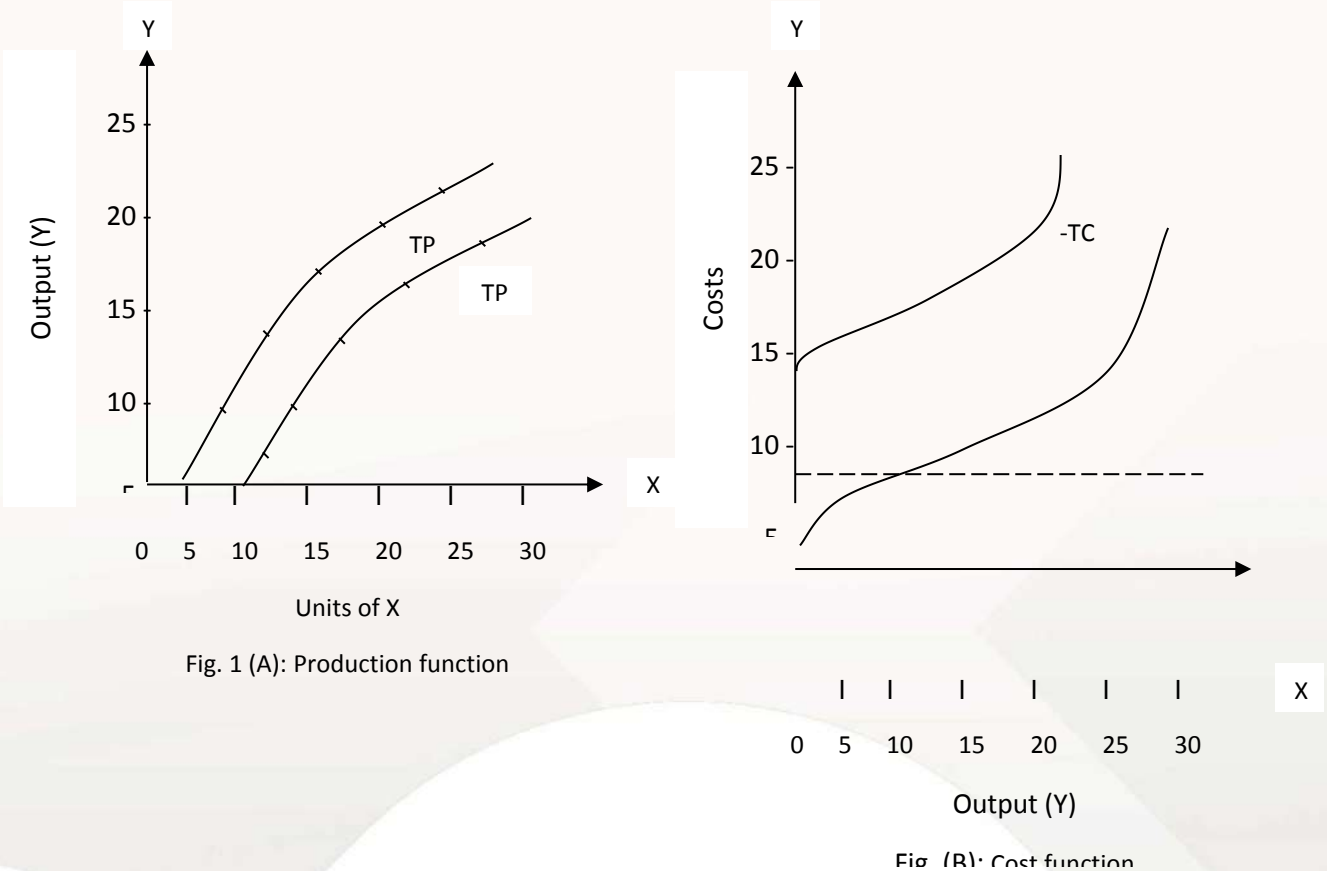

Fig. 1 (A): Production function

Fig. (B): Cost function

The curve TP in (fig. A) shows the relationship between output and use as well as cost of input at constant prices. Since each unit of input costs the same amounts this curve is identical to the production function in which 'y' is a function of the variable input 'x' in physical terms.

There are also fixed costs involved in the production of 'y', fixed costs can be shown by moving the production function to the right on x-axis by a distance equal to the fixed costs. In this case, the amount of

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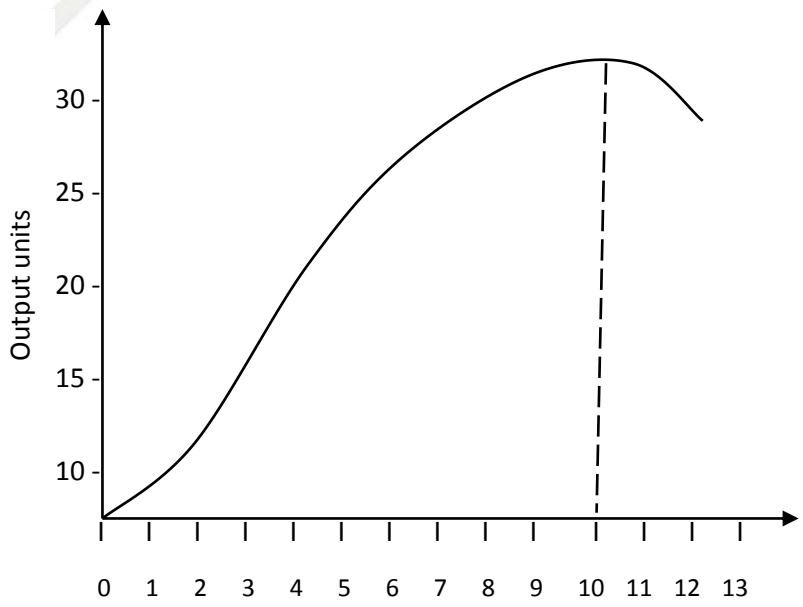
fixed cost is represented by the distance OA. Note that fixed costs do not change the shape of the curve, only the position is affected.

When cost is thought of as related to output, cost curves are portrayed with cost on the vertical axis and output on the horizontal axis as shown in Fig 1 B. The total cost curve in Fig. 1 B is the same curve as TP in Fig. 1 A only the graph is turned sideways and back ward. Total product curve and total cost curve are thus related in the reverse order.

There are logical reasons for expecting the total cost curve to have the general form as shown in Fig. 1A. Since each additional unit of input has a cost, we would expect the total cost curve to rise throughout its entire range. Only if the variable inputs were free, would the total cost curve go a horizontal that is the cost will be independent of output. We would expect the average cost to fall as output increases because fixed cost will spread on more and more number of units as the output expands. Under such conditions it would cost less per unit to produce more and consequently, the rational producer would continue to expand his production. In doing so, he would continue increasing his net revenue.

On a production function of classical type (Fig. 2) we would not expect the farmer operating in a region in which total cost will increase as production decreases (Region – III). Hence, from the view point of a firm, one would expect the total cost curve to lie between the limits of a horizontal and vertical line as does the total cost curve in Figure 2 B



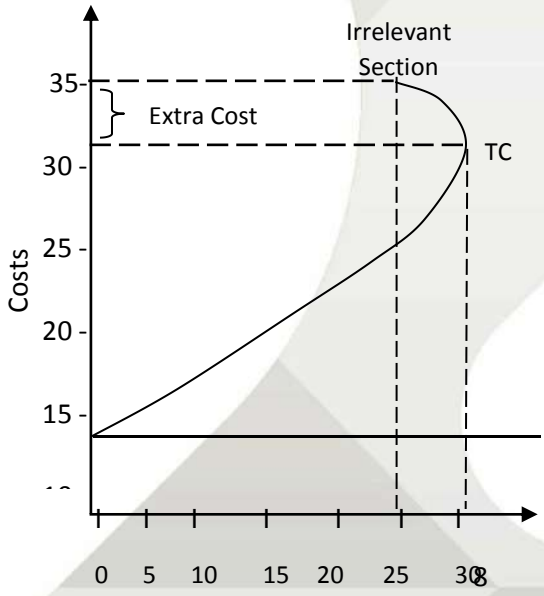


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Fig. 2A: Different production regions of production function Fig. 2B Total cost function.

4.3. Relationship between TFC, TVC and TC

Table 1. Relationship between production function and costs

Input units	Total output units	TFC	TVC	TC
0	0	15	0	15
1	2	15	2	17
2	5	15	4	19
3	9	15	6	21
4	14	15	8	23
5	19	15	10	25
6	23	15	12	27
7	26	15	14	29
8	28	15	16	31
9	29	15	18	33

10	29	15	20	35
11	28	15	22	37
12	26	15	24	39

The production function is given in column 2. For the sake of simplicity Rs. 15 is assumed to be the cost associated with the fixed inputs used in the production process and the variable cost is that which is incurred in purchasing the variable input (s). Note that production function has single total product curve but in cost function, the total cost curve represents two categories of cost i.e., fixed costs and variable costs.

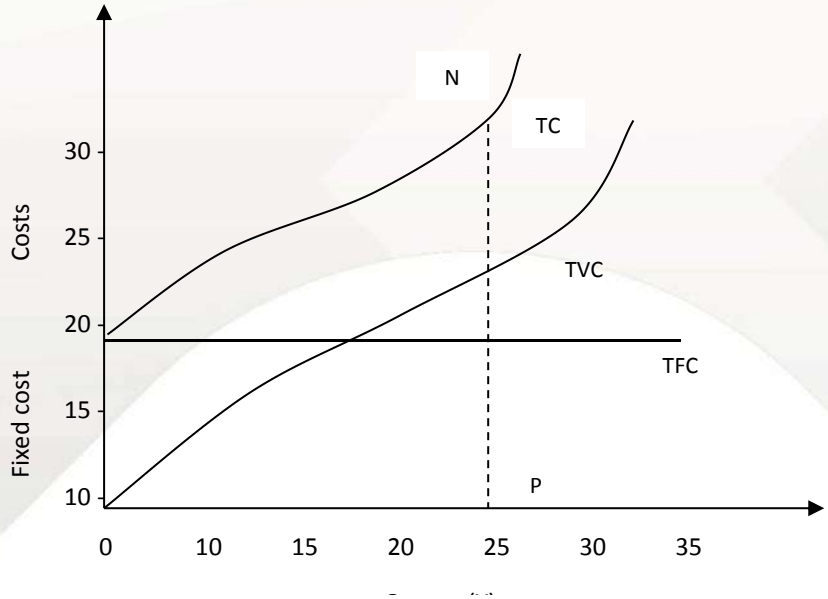

Fig. 3: Relationship between TFC, TVC & TC

TFC: This is known unchanging. This is represented by a straight line parallel to the horizontal or 'x' axis and located 15 units up the vertical scale.

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TVC: It is zero when output and consequently the input is zero. It increases as output increases. The shape of the TVC curve depends upon the shape of the production function.

TC = TFC + TVC or TC = TFC + Px (X)

The TC curve is equal to the vertical addition of TFC and TVC on this graph. It is shaped exactly like the TVC curve but it always higher by units of TFC on vertical axis. The shape of the TC curve, like that of the TVC curve, depends upon the production function.

5. Relationship between Average Fixed Cost, Average Variable Cost, Average Total Cost

Average fixed cost (AFC): It is fixed cost per unit of output. It is worked out by dividing total fixed cost by the amount of output. AFC will vary for each level of output. As output increases, AFC decreases. Thus, when economists refer to increasing output as a one word "Spreading fixed costs" they mean increasing production to divide total fixed costs among more and more units of output thereby reducing cost per unit. Here the output level changes but fixed cost remains the same, thus the decreasing fixed cost per unit of output. When output is zero AFC = TFC. AFC always slopes downwards regardless of production functions.

Average Variable Costs (AVC):

$$AVC = \frac{TVC}{Q}$$

AVC varies with level of production; the shape of the AVC curve depends upon the shape of the production function. The height of the AVC depends upon the unit cost of the variable input. Like AFC, AVC

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cannot be computed when output is zero. Average variable cost is inversely related to average physical product. i.e., when APP is increasing AVC is decreasing. When APP is maximum, AVC attains minimum. When APP is decreasing, AVC is increasing. AVC first falls due to economies of large scale production and then rises due to diseconomies of scale in production.

Thus, as on a production function APP measures the efficiency of the variable input, for cost curves AVC provides the same measure i.e.

Characteristics of Average cost curves

(i) Average fixed cost curve will continue to decline and never show upward movement because after maximum product is achieved, inputs beyond this become irrational.

(ii) As the production expands, the AVC keeps on declining. It reaches a lowest point and then bends upward. At this point APP is the highest (Fig 4).

(iii) Average total cost curve has the same shape as AVC. Difference is that the lowest point in case of AVC reaches earlier as compared to ATC.

Marginal cost

Marginal cost is the change in total cost in response to a unit increase in output at the margin. It is the change in cost associated with an increase or decrease of an additional unit of output. It is in other words cost of producing an additional unit of output and is computed by

$$MC = \frac{\Delta TC}{\Delta Y}$$

Actually a change in total cost is always equal to the change in variable cost at a given level of fixed cost. MC could also be, therefore, worked out by dividing the change in variable cost by the change in output.

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Characteristics of marginal cost

As output increase, MC first falls due to more efficient use of the variable factor (s) of production and then it slopes upwards due to less efficient use of the variable factor of production and then it slopes upwards due to less efficient use of the variable factor(s). Marginal cost is related to marginal product in the same manner that AVC is related to AP.

$$\boldsymbol{MC = \frac{\Delta\, Cost}{\Delta\, Y}}$$

but Δ cost = Px Δx

$$\boldsymbol{MC = Px.\ \frac{\Delta\, X}{\Delta\, Y}}$$

$$MC = \frac{Px}{\Delta y/\Delta x}$$

but Δy/ Δx = MPP

$$MC = \frac{Px}{MPP}$$

From the above equation, the following relationships can be deduced

(i) When MP is at the maximum, MC is at the lowest point
(ii) When MP is increasing, one is decreasing, and
(iii) When MP is decreasing, MC is increasing

Relationship between Average cost & Marginal cost

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MC has a definite relationship with ATC & AVC (Fig. 4)

1) AVC & ATC curves will slope downwards & keep falling as long as MC curve is below them.
2) Conversely AVC & ATC curves will move up when MC curve is above them.
3) MC curve will intersect the AVC curve at the lowest point from below.
4) As MC curve moves on, it intersects the ATC curve form below at the lowest point. The only difference is that MC curve intersects the AVC curve earlier than ATC curve.

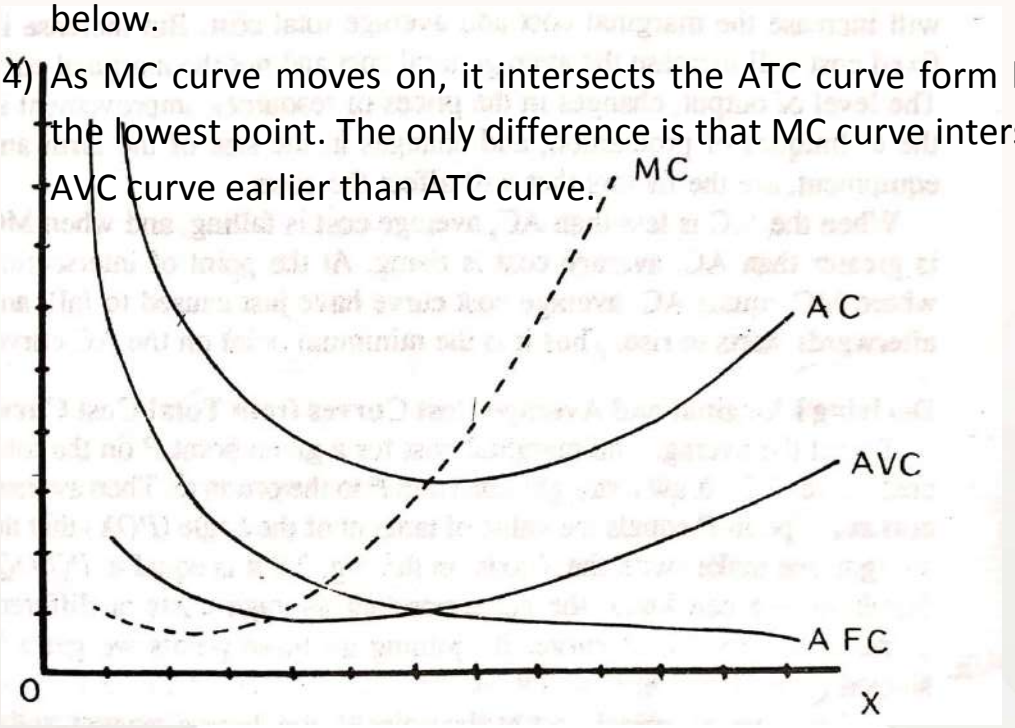

Fig. 4: Relationship between AFC, AVC, AC & MC

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Course Name	Farm Management, Production & Resource Economics
Lesson 9	Managing Farm Business
Content Creator Name	Dr G M Hiremath
University/College Name	University of Agricultural Sciences Raichur, Raichur
Course Reviewer Name	Dr. Dhruv Kishor Sinha
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Objectives

1. To give a thought to the importance of cost in managing farm business.
2. To learn about estimation of farm business income and efficiency measures.

Glossary

Poly-period resources: Which represent stock of services (transfer services) and only a part of these stocks of services is transformed into product in each distinct production period.

Mono-period resources: Which also represents a stock of services (seed, fertilizer) but here entire stock of services is transformed into product in a single period.E,g., seeds, fertilizer

Cost of production: It is referred to the expenses incurred per unit of output.

Cost of cultivation: It is referred to the expenditure incurred per unit area.

I. Cost concepts and income measures

1. Farm costing:

Cost refers to money value of effort expended or sacrifice made in producing an article or rendering a service or achieving a specific purpose.

Economist has developed different cost concept and new ideas which are more relevant to planning and control of business activities. The overall object is cost efficiency through appropriate techniques of cost control and cost reduction. As such, almost all forms of business decisions centre on cost, so the cost efficiency could be a reality.

2. Importance of cost in farm management

(a) It helps in choosing from among varied alternative courses of action.

(b) It helps in determining the optimum level of operation in accordance with the behaviour of cost in relation to scale of operation.

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(c) It helps in price decision.

(d) In deciding the replacement of capital equipment by a new one, cost information is vital.

(e) In deciding whether to sell a product at one stage of processing or further processing it, cost data are needed.

(f) In deciding the acquisition of fixed assets, again cost is a relevant factor.

(g) To decide whether equipment is to be bought or hired cost data are essential.

(h) Lastly, cost plays a vital role in performance evaluation and returns analysis.

(i) There are different cost concepts but all are not relevant in all decisions

3. Opportunity cost versus actual cost

It refers to the value of benefits of a foregone alternative. Simply it means the income from the missed alternative. It follows that opportunity cost would arises only when there are alternatives. It is specially used in resources allocation problems, when the resource in question can be put to plural uses but one at a time.

4. Out-of-pocket versus imputed

It refers to the cost that involves an actual outlay of cash immediately, or in the near future. Material cost, labour cost and interest on borrowed funds are examples of out-of-pocket cost. On the other hand imputed cost does not involve actual outlay it refers to assumed or hypothetical cost. It includes the assumed cost of using owned resources for the business carried on by the farm owner himself. Assumed interest on owned capital, assumed remuneration for owner's service or family labour contribution, assumed rental charges on owned land, are some typical examples. For decision making, the imputed cost is irrelevant, as it does not affect the business funds and the cost of operation of the farm business. On the other hand, cost

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involving actual outlay is relevant as the farm manager can plan it and exercise control over it.

5. Cost concepts

Its approach to farm costing is widely used in India. These cost concepts, in brief, are Cost-A1: Cost-A2: Cost-B and Cost – C. The different cost items that are to be included under each cost concept are detailed below with their imputation procedures and examples.

Cost-A1: it includes the value of:

- casual hired labour
- attached labour
- hired bullock labour
- imputed value of owned bullock labour
- hired machine labour
- imputed value of owned machine labour
- seeds
- manures and fertilizers
- plant protection chemicals
- irrigation charges
- interest on working capital
- depreciation
- land revenue
- The total of all these cost items make up cost-A1.

CostA2 = CostA1+rent paid for leased-in land, if any.

Cost-B: Cost A2+ imputed rental value of owned land +interest on owned fixed capital.

Cost-C: Cost B + imputed value of family labour. Cost-C is the total cost of cultivation or gross cost.

1. Measures of returns over different cost concepts:
   a. Farm Business income (FBI)

      FBI = Gross income – Cost A1

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b. Family Labour Income (FLI)
   FLI = Gross income – Cost B

c. Net Income (NI)
   NI = Gross Income – Cost

d. Farm Investment Income (FII)
   FII = FBI – Wages of family labour

Cost concepts are widely used because of their relevance in the decision making process. This means that these costs serve as a basis to expand the size of the farm, to buy the requisite capital assets in the long run and the requisite inputs in the short run. For example variable costs have a bearing on the level of production in the short run, on the other hand the decision like expanding the size of the farm buying the durable assets, etc are based on the total costs.

The classification of costs based on Dr. Sen's committee report (1979) is as follows.

Cost B1= Cost A1 or A2 + interest on amount of owned capital invested in the business excluding the value to land.

Cost B2 = Cost B1 + rental value of owned land less land revenue + rent paid for leased in land.

Cost C1 = Cost B1 + imputed value of family labour.

Cost C2 = Cost B2 + imputed value of family labour.

Income Measures

These are the returns over different cost concepts different income measures are derived using the cost concepts.

(1) Farm business income = Gross income – Cost A1 / A2

(2) Family labour income = Gross income – Cost B

(3) Net income = Gross income – Cost C

(4) Farm investment income = Farm business income- imputed value of family labour

Or

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= Net income + imputed rental value of owned land + interest on owned fixed capital invested.

II. Farm Efficiency Measures

Farmer makes several decisions in the use of resources. Mere decision making may not result in profitable organization of the farm business. There is need to evaluate the decisions of the farmer for which we need some guidelines and standards. Here comes the role of efficiency measures, these are categorized into physical and financial efficiency measures.

1. Physical efficiency measures

Broadly three types of physical inputs viz., land, labour and capital are used on the farms. Every farmer aims at the efficient utilization of these inputs. Following are some of the criteria, yardsticks or indicators to express the efficiency of these physical inputs.

1.1 Land: - It is measured by productivity, cropping intensity and crop yield index.

(***i) Productivity of land:***

$$\frac{\text{Actual crop yield on the farm}}{\text{Average yield in the locality}} \text{ X } 100$$

$$\frac{40 \text{ x } 100}{30} = 133\%$$

(***ii) Cropping intensity:***

$$\frac{\text{Gross cropped area during the agricultural year}}{\text{Net cropped area}} \text{ X } 100$$

$$\frac{30 \text{ x } 100}{10} = 300\%$$

(iii) Crop yield index: It is a good measure of index to compare the yields of all the crops grown in the farm with that of average yields of the

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same crops grown in that locality. The index is measured in terms of percentage.

Estimation of crop yield index

Crop	Average yield		Crop average on selected farm (ha)	Production efficiency	Production efficiency * Crop average
	Given locality	Selected farm			
Paddy (qtl)	68	80	4	117.65	470.60
Sugarcane (tonnes)	90	110	6	122.22	733.32
Total			10		1203.92

Crop yield index = 1203.92/10 = 120.39

Thus the farm in question is more efficiently organized in terms of crop yields as compared to an average farm in the area since the crop yield index is more than 100

1.2. Labour

Crop acreage per man equivalent year, livestock maintained per man, gross income per man and productive man work units per man equivalent year are the important measures of labour efficiency.

Labour is measured in terms of man days. As farmer employs men, women and child labours on the farm, it is necessary to convert them into man equivalent days. Taking the efficiency into consideration, three women are considered as equivalent to two men and two children are equal to one man. By taking these ratio into consideration women and child days will be converted into man equivalent days. The sum of all man

days and man equivalent days is divided by 365 days to get man equivalent year.

Example: Paddy crop requires 100 men labour, 120 woman labour and 50 child labour per hectare.

Man days = 100

Woman labour converted into man equivalent day = 120 * 2/3

= 80 man equivalent days

Child labour converted into man equivalent days = 50 * ½

= 25 man equivalent days

Sum of man days + man equivalent days = 100 + 80 + 25

= 205 man days

Man equivalent year or person year = 205/365

= 0.56

Labour efficiency measures

(i) Crop acreage per man equivalent year: It is one of the simplest methods of measuring the productivity of labour input and is calculated by dividing the number of acres under crops by man equivalent year. Higher the ratio greater the productivity or efficiency.

(ii) Livestock maintained per man: - It is arrived as by dividing the total livestock maintained on the farms divided by man equivalent year.

(iii) Gross income per man: - It is calculated by dividing gross income obtained on the farm by man equivalent year.

(iv) Productive Man Work Units per Man Equivalent Year (PMWU): assuming average efficiency, the work done by the worker in a day of eight hours is known as productive man work unit i.e., man days.

To work out total productive man work units, we require information on the average requirement of productive man work units per unit for all the enterprises taken up on the farms as well as the size of each enterprise.

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Estimation PMWU per man equivalent year

Name of the enterprises	Area (in ha)	Average reqt. of the productive man work units per unit	Total productive man work units (man days * size of the enterprise)	
Paddy	5	250	1250	3.42
Groundnut	4	120	480	1.32
Dairy	3	40	120	0.33
Total			1850	5.07

$$\text{PMWU} = \frac{\text{Total productive man work units}}{\text{Man equivalent year}} = \frac{1850}{5.07} = 365$$

2. Financial Efficiency Measures

Though the physical efficiency in the use of resources is essential, but the economic efficiency ultimately decides the success or failure in the organization of the farm business. The financial efficiency measures are classified into aggregate and ratio measures.

2.1. Aggregate Measures: - Aggregate measures are the measures meant to reflect the income earned by the various factors of production for the farm as a whole. Here the entire farm is considered as a unit and efficiency is worked out for the entire farm in terms of each resource used. Following are the aggregate measures.

i. ***Total capital invested:*** - Investment in fixed assets (land, bldg.) and working assets (livestock, machinery, equipment, etc) together represent the size of the farm.

ii. ***Total value of production (Gross income):*** It is the total income derived from the sale of main product as well as byproducts

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from the enterprises taken up by the farmer in a year. This includes value of home consumed products plus the value of products sold.

iii. ***Total expenses:*** These include working costs and fixed costs of the farm.

iv. ***Net worth:*** It is the surplus of total assets over the total liabilities.

Net worth or equity = Total assets – total liabilities.

The high level of net worth indicates strong financial position of the farm at a point of time. Balance sheets proposal over the years indicate financial progress of a farm business.

v. ***Net cash income:*** The surpluses of cash income over cash operating expenses indicate net cash income. This is the amount available with the farmer for future investment on the farm.

Net cash income = Gross cash income – cash expense

vi. ***Net farm income:*** It is worked out as

Net cash income $\pm$ change in the inventory – depreciation

vii. ***Farm earning:*** It is computed as

Net farm income + value of farm products consumed at home

viii. ***Family labour earning:*** It is farm earnings less interest charges on fixed capital.

ix. ***Returns to management:*** It is computed using the following equation.

Return to management = Family labour earnings – Imputed value of family labour.

2.2. Ratio measures: These measures reflect per unit returns or costs to the inputs involved in the organization of the farm business.

(***i) Fertilizer cost per crop acre:*** This varies from crop to crop and farm to farm.

Total expenditure on fertilizers

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No of acres under crop

(ii) Power and equipment cost / crop acre: This relates to running costs incurred in operating power drawn machinery per acre of cropped area.

(***iii) Cost Ratios:*** This helps to decide whether the existing costs of the business farm are higher or lower. These ratios indicate what proportion of income is spent for meeting different types of expenditure.

$$\text{a) Operating ratio} = \frac{\text{Operating expenses on the farm}}{\text{Gross income on the farm}}$$

(b) Fixed ratio: It gives the proportion of fixed expenses in gross income of the farm.

$$= \frac{\text{Fixed costs on the farm}}{\text{Gross income on the farm}}$$

(c) Gross ratio: Gross ratio is the ratio of total costs of the farm to the gross income.

$$= \frac{\text{Total cost on the farm}}{\text{Gross income on the farm}}$$

(iv) Solvency ratios: These ratios measure the degree of financial safety (solvency) and liquidity of comparable business farms at a point of time. These ratios include.

$$\text{a) Current ratio:} \quad \frac{\text{Current assets}}{\text{Current liabilities}}$$

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$$\text{b) Working ratio} = \frac{\text{Current assets + intermediate assets}}{\text{Current liabilities + intermediate liabilities}}$$

$$\text{c) Net capital ratio} = \frac{\text{Total assets}}{\text{Total liabilities}}$$

$$\text{d) Debt equity ratio} = \frac{\text{Total liabilities}}{\text{Owner's equity}}$$

V) Income ratios

$$\text{Net income per acre} = \frac{\text{Net income}}{\text{No. of acres}}$$

(vi) Capital ratios:

(a) Capital per unit of gross income: It is computed by dividing total capital invested by gross income.

(b) Capital per man: It is worked out by dividing the total capital invested by the number of man equivalent years.

(c) Rate of capital turnover: It indicates the number of years it will take for the farm to return the investment through income.

$$\text{Rate of capital turnover} = \frac{\text{Gross income on the farm}}{\text{Total value of farm assets}} \times 100$$

Course Name	Farm Management, Production & Resource Economics
Lesson 10	Farm Records
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University/College Name	University of Agricultural Sciences Raichur, Raichur
Course Reviewer Name	Dr. Dhruv Kishor Sinha
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Objectives

1. To understand the importance of farm records and accounts in managing a farm.
2. To make familiar the different types of farm records and accounts that are needed to maintain a farm.

Glossary

Credit: A credit is an entry made on the right side of an account. It either increases equity, liability, or revenue accounts or decreases an asset or expense account. Record the corresponding credit for the purchase of a new computer by crediting your expense account.

Debits: Debits increase asset or expense accounts and decrease liability, revenue or equity accounts.

Farm records and accounts:A farm record is a document (in most cases a book) that is used to keep account of different activities, events, materials etc. regarding the farm operations. Farm records are different from farm accounts in the sense that farm accounts deal only with the financial aspects of all farm operations.

Credit worthiness:the extent to which a person or company is considered suitable to receive financial credit, often based on their reliability in paying money back in the past.

1. Importance of farm records and accounts

Farm business has become more complex due to technological, economic and social changes. The successful organization of the farm business depends on the experience of the organizer. Farm records

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preserve the value of experience. No business worth its name today operates without the maintenance of records. Farming is also a business and therefore there is greater need to keep proper recording system of all the business transactions that take place on the farm. The main objectives of farm records are to control the farm business, guide future decisions and provide data required for sound farm planning.

Benefits of farm records

The benefits of maintaining farm records are presented below

a) Planning: Identification of defects in the existing organisation of farm business is the first step in farm planning. Analysis of farm records helps in diagnosing the omissions in the current plan. It also provides data required for farm planning.

b) Management: Maintenance of farm records inculcates the business outlook as well as better insight into the working of farm business. Systematic recording of farm business transactions helps the farmer in knowing the strengths and weakness of the business. Once weaknesses are brought into fore, the recurrence of the same can be avoided in future and thus leading to the improvement in the management.

c) Farm returns: Farm records help to check the unproductive expenditure and identify profitable enterprises. Besides, the gap between current income and potential income can be examined as the records are the sources to know the present income on the farm once this gap is identified, suitable corrective steps can be taken to improve the returns on the farm.

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d) Research and government policies: To conduct research we need precise data on costs and returns similarly formulation of various programmes for betterment of agricultural sector, the government also needs authentic data. Well maintained records provide required information for the research and the government.

e) Credit: The records provide information on the income generating capacity of the farm and truly indicate the credit worthiness of the farmers. This enables the farmer to get required credit form the financial institutions.

f) Input management: Records indicate the requirement of various inputs and input services in advance so as to organise the farm business smoothly.

2. Limitations in the Maintenance of Farm Recordsor Difficulties in Maintenance of Farm Records

a) Illiteracy: Majority of the farmers does not have the reading and writing abilities as a result they do not show any interest in the maintenance of records.

b) Small size holdings: Small farmers do not feel it is worth to maintain the records in view of meagre amount of farmer.

c) Fear of taxation: Farmers are apprehensive of the taxation on their income and so they do not like to record the particulars of income.

d) Complicated nature: Majority of the farmers are used to memorize the various transactions of farm business from time immemorial and they feel that it is a cumbersome to maintain records even the farmers are literate.

e) Nature of Farming: Farming is a laborious work which involves not only the physical work but also mental work. Farmer works on the farm from

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morning to till evening, therefore he does not feel comfortable to sit and work all the business transactions that have taken place on that day.

3. Types of Farm Records

There are two types of records maintained on the farm.

3.1. Physical Record maintained on an Average farm

1. Farm map
2. Land use records
3. Permanent dead stock register
4. Farm livestock records
5. Farm labour records
6. Input records
7. Feed records
8. Crop production and dispersal records
9. Livestock production and dispersal records
10. Input and feed stock register and
11. Log book.

3.1.1. Farm map: - It is one of the most simple and brief record of farm features. It gives a visual impression or a bird's eye view of the whole location of the farm business. It indicates relief feature of the farm business. The farm map does not replace the actual observation of the physical situation or location of the farm. Personal observation is very necessary and the farm map is just supplementary to the physical spot observation.

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3.1.2. Land utilization record (Area in acre)

Name: ABC farm

Land use	2008-2009	2009-2010
Cultivated land	9.00	9.00
Irrigated		
Un irrigated	0.60	0.60
Garden		
Idle Land		
Total	9.60	9.60

3.1.3. Production records

The importance of production records cannot be over emphasized. Production records provide standard of performance in the use of resources. They help to have plans based on facts of actual performance instead of guesses. The farm and type of physical records relating to crops or livestock enterprises will depend upon the degree of specialization and the type of farming followed.

Crop production and disposal record.

Name of farmer: _____

Total area _____ acres

Crop enterprises	Last year Balance Qty value	Production					Disposal				Sold		Balance	
		Field No	Area (acre)	Yield /acre	Total Prodn.	Value	Domestic Consumption Qty value	Used as Seeds Qty value	Feed to Cattle Qty value	Kind payments Oty value	Qty Qtl	Value (Rs)	Qty Qtl	Value (Rs)
Maize Hybrid														
Cotton														
Sugarcane														

Livestock production and Disposal record:

Items	Production				Disposal			
	Previous balance	**Purchased**	**Produced**	**Total**	**House hold Consumption**	**Died/ loss**	**Sold**	**Balance**
a) Milk animals Buffaloes Cows Milk products Ghee b) Poultry Eggs c) Others								

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3.1.4. Permanent Dead stock Register: The data facilitate the extent of wear and tear of the items, so that extent of repairs or even replacements he has to undertake can be given

Particulars	Year of construction/ Purchase	Construction value/ purchase value (Rs)	Amount spent on repairs per annum (Rs)
1) Farm buildings Cattle shed Well / tube wells Pump house Tractor Oil engines etc			

In respect of certain items on which large amounts are incurred for repairs annually, the farmer may think in terms of disposal or replacing.

3.1.5. Labour records: Labour records can be of two categories.

3.1.5.1. Simple labour records: - This is for selected enterprises or operations. It may often be useful to keep a record of the labour used on one or more enterprises where there is some special reason to study efficiency of each seasonal requirements. Also labour figures may be used to determine whether a particular enterprise with high labour requirements such as vegetables in profitable. At the end of each day enter the number of hours of labour and tractor work for each quality. Make a summary for the year by totalling the columns.

Simple farm labour record.

Season ------- Crop----------Variety----------Area---------acres

Date of operation	Owned labour					Hired labour					Wages in Rs.				
	TP	CP	M	W	C	TP	CP	M	W	C	TP	CP	M	W	C

TP= Tractor power CP= Cattle power

3.1.5.2. Complete labour record.

Sometimes the distribution of labour on the entire farm is required to be studied. to obtain a complete record, the amount of time each worker on the farm spent each day and on each enterprise is recorded, to find out how efficiency each of the principal operations such as ploughing, harrowing, harvesting, etc was performed, the records must specify not only the enterprise but also the size of the machine and the implements.

3.1.6. Heavy machinery use record. (Log book)

The use of machines on bigger farm organisations constitutes a heavy cost which needs to be economized. To have a full control over machine use and to study the performance of different machines, there is need to maintain proper machinery use records. For example log book can be maintained for a tractor.

Log book

Name of the machinery: Tractor

Size : 35 HP

Company : Massey Ferguson

Date of purchase : April 2014

Date	Nature of work done	Period used in a day			Distance covered	Fuel consumption		Lubricants used		Repair	Remarks
		From	To	Hrs		Qty	Rs	Qty	Rs.		
20-4-14	Ploughing										
21-4-14	Harrowing										
22-4-14	Ploughing										
23-7-14	Transplanting										

3.1.7. Feed records

The details of daily feed expenditures can be maintained the feed particulars also indicate as to whether the livestock was given required ration or not so that feed efficiency can be worked out.

Date & Month	Type of Feed	Milk animal		Draft animal		Young animal		Poultry	
		Qty	Rs.	Qty	Rs.	Qty	Rs.	Qty	Rs.

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3.1.8. Input record

It gives a picture of the extent of different inputs utilized crop-wise and variety wise. The actual use indicates whether a particular input was over- used or underutilized. The imbalances if any can be corrected from the data available in these records.

Date/ month	Input	Quantity	Rate (Rs)	Value (Rs)

3.2. Financial Records

These records are mainly related to the financial aspects of the operation of a farm business. These records are on:

1) Farm inventory
2) Farm cash accounts or farm financial accounts.
3) Classified farm cash account and annual farm business analysis
4) Supplementary financial records
    (a) Capital assets sale register
    (b) Cash sale register
    (c) Credit sale/ purchase register

(d) Wage register

(e) Funds borrowed, repayment register

(f) Farm expenses (paid in kind) register

(g) Non - farm income record.

3.2.1. Farm inventory:

It is a list of all the physical property of a business along with their values at a specified date. It is the complete list of farmer's assets.

Purposes:

1) It will give a list of all the assets with their values. It shows what amount of capital accumulation goes back in to the business. It is a necessary step in complete farm accounting.
2) It reveals the changes in net worth through comparison of a farm inventories taken at the beginning of the year with another assembled at the end of the year. It provides bases for computing growth in networth.
3) It enables to work out the measures of income.
4) It enables to determine the depreciation costs.
5) It helps to work out the value of a last year's takeover of stocks and this year's left over's.
6) Basis of income statement.

Time: - On most farms is at the beginning of the agricultural year on or near first July.

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Two things to be kept in mind

i) Lesser need of price estimates

ii) Convenience

Process of taking Farm inventory

i) Physical counting

ii) Valuation of physical assets.

The farmer with a critical eye should walk over his farm and through the buildings to make a general inspection of the land, buildings, fences, equipment, livestock supplies. The physical count is necessary to verify numbers, weights and measurement.Next the farmer should place on each item using an appropriate valuation method.

3.2.2. Farm cash account

These records relate to the annual operation of the business and the profits and losses associated with it. Whereas the farm inventory is a record of the financial condition at a particular point of time, the farm cash account is a record of the results of the operation of the farm over a period of time usually one season or one crop year.

3.2.2.1. Types of cash accounts

3.2.2.1.1. Farm diary: Diary is meant for daily recording of all important events on the farm. It may include weather report, any unusual events of the day, as well as cash receipts and expenses from all resources.

3.2.2.1.2. Farm business cash record:-It is a record of all cash receipts from all cash expenses incurred on the farm business. The farm business

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cash record omits all personal cash expenses and all non– farm cash income. The objective of his record is to measure changes in the farm business only as far as cash transactions are concerned. The business cash record can be maintained in a simple farm or classified farm.

3.2.2.1.3. Personal cash record: It is strictly a record of all personal expenses of the farm family, exceeding all the farm costs and usually a recording of the cash income of the family farm all sources, regardless of whether the income is from farm or non–farm sources.

3.2.2.1.4. Complete cash record: It includes expenses on all items both personal and business and income from all sources recording according to source types.

3.2.3. Classified Farm Cash Record: The classified cash record is a modified and more complicated form of the simple cash record meant to provide more detailed facts about the farm business that can be obtained from the simple cash record. It provides details of the costs and returns from the different farm enterprises, as well as a general summary of the cash costs and returns from the entire farm business.

Simple Farm Cash Record of ABC Farm

Date	Expenses		Receipts		
	Particulars	Amt	Date	Particulars	Amt (Rs)
July 2009	Urea 20Q @ Rs 500 PPC		July2009	Sale proceeds of milk Sale of	

	Navacron 3 litres Electricity Charges			proceeds of milk	

Limitation of the cash accounts:

The cash account does not provide facts which will show the gain or loss or any measure of real profit for the farm as a whole for any specific year or given period of time, e.g., transactions in the cash account record are restricted to those of the cash only. It does not also show gains or losses for different enterprises which make up the farm business.

3.2.3.1. Income Statement

The Objective of preparing the income statement is to summarize the data on income and expenses to present a truthful picture of the year's performance. An income statement is the list of all farm expenses or business debts on one Land and all receipts or business credits on the other. After bringing these together in a convenient form, expenses are subtracted from receipts to determine the net income for the year.

3.2.3.2. Journal: All business transaction is first recorded in book called journal. It means a daily record. The journal is also called as a 'book of original entry'

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3.2.3.3. Ledger: ledger is the chief book of accounts. A ledger is a book which contains various accounts to which the entries made in the journal are transferred (journal gives information in the form of entries, whereas ledger contains information in the form of accounts).

3.2.3.4. Cash book: - Transactions relating to only cash are recorded in one book called cashbook. The principle here is, cash coming in is placed on debit side and cash going out is entered in credit side.

3.2.4. Supplementary / Subsidiary records

3.2.4.1. Credit sale / purchase register: **-**It is meant for recording goods purchased on credit and recording credit sales of goods only

3.2.4.2. Cash sale register: **-** It is meant for recording cash sales of goods only

3.2.4.3. Final accounts:

3.2.4.3.1. Trading account: **-** It gives the details of purchase, sales. Purchase returns, sales returns, carriage (carriage in wards) manufactory expense, etc. Trading account gives gross profit the business.

3.2.4.3.2.Profit and loss Account: It contains the particulars of salaries, rent, rates and taxes, advertisements, carriage outwards, depreciation, commission received, interest received, etc,. It gives net profit or net loss of the business.

3.2.4.3.2. Balance sheet: It is statement containing balance of fixed assets, current assets, liabilities and capital. It gives the financial position of the business. Fixed assets include buildings, machinery, furniture

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(tangible fixed assets) and good will, patents, trademarks, copy rights, etc, (intangible fixed assets)

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Classified Farm Cash account of ABC farm for the year 2013-14

Sl. No.	Date	To whom or what sold	Items & price per unit	Qty	Cotton	Maize	G.nut	Sugar cane	Milk product	Poultry	Capital sales & money borrowed		
											Live stock sales	Machinery sales	Loan borrowed
		Milk society											
		Crop market society											

(a) Cash receipt

(b) Cash expense

Date	Description of transaction	Cash spent &custom charges	Labour Permanent / Temp	Fuel & oil	Machinery building repair	Electricity	Fertilizer	Seeds	PPC	Capital cost		
										Machinery	Bullock	Kind payment

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Course Name	Farm Management, Production & Resource Economics
Lesson 11	Selection of Crops and Livestock Enterprises
Content Creator Name	Dr G M Hiremath
University/College Name	University of Agricultural Sciences Raichur, Raichur
Course Reviewer Name	Dr. Dhruv Kishor Sinha
University/college Name	Dr. Rajendra Prasad Central Agricultural University, Samastipur

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Objectives

1. To understand the linear programming approach for optimum resource allocation.
2. To understand the different tools for appraisal of farm resources like farm planning and budgeting.

Glossary

Planning: Future course of action
Linear: having a graph that is a line and especially a straight line.
Farm resources: Land, family labour, ox power, tractors and machinery, crop storage space, fences and livestock housing are examples of service-generating **resources** which provide their services as a flow over time.
Budget: Estimated expenditure and income for a given year.

1. Linear Programming

1.1. Introduction

Linear programming was developed by George B Dantzig (1947) during second world war. It has been widely used to find the optimum resource allocation and enterprise combination. The word linear is used to describe the relationship among two or more variables which are directly proportional. For example, doubling (or tripling) the production of a product will exactly double (or triple) the profit and the required resources, then it is linear relationship. Programming implies planning of activities in a manner that achieves some optimal result with restricted resources.

1.2. Definition of L.P.

Linear programming is defined as the optimization (Minimization or maximization) of a linear function subject to specific linear inequalities or equalities.

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Max z $\sum_{j=1}^{n} cjxj\,j$

St

$$\sum_{i=1}^{n} aij < bi \qquad \text{i} = 1\text{to n}$$

$x_j = 0$

c_j = Net income from j^{th} activity

x_j = Level of j^{th} activity

aij = Amount of i^{th} resource required for j^{th} activity

b_i = Amount of i^{th} resource available

1.3. Assumptions of Linear Programming

a) **Linearity**: It describes the relationship among two or more variables which are directly proportional.

b) **Additivity**: Total input required is the sum of the resources used by each activity. Total product is sum of the production from each activity.

c) **Divisibility**: Resources can be used in fractional amounts. Similarly, the output can be produced in fractions.

d) **Finiteness of activities and resource restrictions**: There is limit to the number of activities and resource constraints.

e) **Non negativity: Resources and activities cannot take negative values**. That means the level of activities or resources cannot be less than zero.

f) **Single value expectations:** Resource supplies, input-output coefficients and prices are known with certainty.

1.4. Advantages of L.P

1. Allocation problems are solved.
2. Provides possible and practical solutions.
3. Improves the quality of decisions.

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4. Highlights the constraints in the production.
5. Helps in optimum use of resources.
6. Provides information on marginal value products (shadow prices).

1.5. Limitations

1. Linearity
2. Considers only one objective for optimization.
3. Does not consider the effect of time and uncertainty
4. No guarantee of integer solutions
5. Single valued expectations.

2. Appraisal of farm resources, selection of crops and livestock's enterprises

a. Farm Planning

Farm planning is the foundation of management. Farm planning precedes all other managerial functions. Without setting the objectives and line of action to be followed, there is nothing to organize, direct or control in the organization of farm business. It is the determination of course of action 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 bridges the gap from where we come to where we are to go. It is characterized as the process of thinking before doing. It is an intellectual process. It requires a mental predisposition to think before acting to act in the light of facts rather than of guesses. 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 not a new technique. It is as old as farming itself. All farmers whether progressive or backward, literate or illiterate plan

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their farm business at the beginning of every crop season as to what crops and livestock enterprises to produce, what amount of resources to be used, how the various operation to be organized what amount of credit to be borrowed, etc. in their minds. This is known as internal planning. As the agriculture is becoming a more complex business, the farmers cannot remember all the necessary information required in order to plan their farm business in a systematic manner. To be more systematic in thinking, the farmers need formal or written farm plans. If the production intention of the farmers is committed on a paper, then it is called a written plan.

"Farm planning is the deliberate process of thinking the organized foresight and the vision based on facts and past experience that is needed for intelligent action on the farm."

Why Farm planning is necessary

1. To choose different farm activities which are suited to the given farm condition.
2. To look into the future and decide on suitable course of action.
3. To select appropriate enterprise combination that results in the better use of resources.
4. To help the farmers in farming various jobs and operations for smooth conduct of operations without competition.
5. To avoid wastages that occurs in the resource use.
6. To provide guidance and flexibility to the farmers for answering better use and growth of the farms.
7. To provide allocation of resources for producing the requisite products for marketing and household consumption.

i. Types of Farm Plans

Simple farm plans: It implies planning for minor changes or for a particular enterprise.

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Complete farm planning: envisages more number of changes in the existing organization. It is adopted for the farm as a whole.

ii. Characteristics of Good Farm Plan

1. Plans should aim at efficient utilization of all available resources on the farm.
2. Plans should be flexible i.e. they should be adaptable to changing environment conditions.
3. Farm plans should be simple and easily understandable. Complex plans consume much time and money, hence are seldom followed. They should take into account the most important suitable farm enterprises, identifying their strengths and weakness.
4. Farm plans should ensure balanced production programme considering the available resources on the farm. The production programme should consist of food crops, commercial crops and fodder crops.
5. The production programme included in the farm plan should aim at maintaining/ improving soil fertility this is possible through suitable crop rotation practices.
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, besides their attitude towards risk.
9. Farm plans should avoid too risky enterprises.
10. Farm plans should make provision for borrowing, using and repaying the credit.

iii. Limitations of farm planning

- It is considered as time consuming and expensive device
- Forecasting methods and statistical data supplied sometimes may not be suitable for all the cases.

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- Planning should be based on actual facts of the farm unfortunately farm records are not maintained by the farmers and hence it is difficult to prepare a good farm plan.
- The pertinent information on farms particularly in respect of climate, water supply, markets etc., is not found in the required format.
- The sources of data for diagnosis and planning are also lacking.
- As a result farm planning is not effectively formulated and implemented.
- Hence data from research stations should be commonly used for this purpose.

b. Farm Budgeting

Farm plan is a programme of total farm activity drawn up by the farmer in advance. The expression of farm plan in monetary terms is called farm budgeting.

i. Farm budgets are classified into

a. Enterprise budget
b. Partial budget and
c. Complete budget or whole farm budget.

Farm budgeting is a method of examining the profitability of alternative farm plans.

1. Farm Enterprise Budget

A commodity that is being produced 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, hectares for a crop, one head of livestock, etc. This facilitates easy comparison between the enterprises. Enterprise budget is the estimation of expected income, costs and profit for an enterprise.

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Organization of Enterprise Budget

It consists of three elements viz., income, costs and profitability. Income is estimated by the multiplication of expected output and expected price. The estimated output is the average yield under normal weather conditions. Output price should be the average price expected in future. In order to estimate the various costs we need information on quantity of inputs used and the prices at which they are purchased. An enterprise budget depicts the input-output relationship in respect of a particular production activity. The enterprise budget includes only variable inputs and the expected output. As distinguished from the cost of cultivation which includes both fixed and variable costs, the enterprise budget includes only variable costs, because the fixed costs are common to more than one enterprise.

USES: Enterprise budgets are used to estimate inputs required, costs involved and expected returns from a particular enterprise. It aids in selection of inputs and enterprises subject to the availability of resources.

2. Partial Budgeting

Partial budgeting is a statement of anticipated changes in costs, returns and profitability for a minor modification.

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, where in 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.

Proposed modification to control tikka leaf spot in JL-24 groundnut variety.

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Items	Amt	Items	Amt
Added costs 200gms of carbendazim + 500gms of Mancozeb	650	Added returns yield 180 at Rs. 20/ kg	3600
Reduced return	Nil	Reduced costs	Nil
Total of added costs and reduced returns	650	Total of added returns and reduced costs	3600

Net Change = 3600-650 = Rs. 2950

The expenditure on fungicides and groundnut yield in existing and alternate situation are presented below

Existing situation	Alternate situation
To control Tikka leaf spot of groundnut carbendazim 0.1% + macozeb 0.25 % at 400gms + 100gms= Rs 1500	To control tikka leaf spot groundnut carbendazim 0.1% + mancozeb 0.25 % at 600gms + 1500gms = Rs. 2000
Yield= 600 Kgs @ Rs 20/kg	Yield = 800kg @ Rs 20 /kgs

Incremental income = 16000 – 12000 = Rs 4000

Example 2: Substitution of sunflower for groundnut

Sl. No.	Particulars	Existing situation	Alternate situation
1.	Human Labour	1500	1000
2.	Bullock Labour	870	830
3.	Manures	860	1000
4.	Fertilizers	1160	1020
5.	Seeds	2200	800
Total operation cost/ ha		6590	4650
Yield (q/ha)		8	9
Price (Rs./q)		1500	1800
Gross income (Rs./ ha		12000	16200

Added costs	Amt (Rs.)	Added items	Amt (Rs.)
Manures	140	Added returns	4200
Reduced return	Nil	**Reduced cost**	
Added cost + Reduced return	140	Human labour	500
		Bullock labour	40
		Fertilizer	140
		Seed	1400
		Total reduced cost	2080
		Total added return + reduced cost	6280

Net change = Rs 6280 -140= Rs.6140

Complete budgeting

1. It is adopted when drastic changes in the existing organization are contemplated
2. All the available alternatives are considered
3. It is a method of estimating expected income, expenses and profit for the farm as a whole

Partial budgeting

1. Adopted when minor changes are introduced on the farm.
2. Considers few or only two alternatives
3. It is used to calculate expected change in profit for a proposed minor modification

Farm budgeting

1. Method of estimating expected income, expenses and profit for the farm business
2. Non mathematical tool
3. It is a trial and error method
4. Computations become tedious and cumbersome.

Linear programming

1. Optimization of linear function subject to linear inequalities or equalities.
2. Mathematical programming models
3. It offers a mechanical process of calculations in the selection of products
4. Computations are easy.

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Course Name	Farm Management, Production & Resource Economics
Lesson 12	Risk and Uncertainties in Agriculture
Content Creator Name	Dr G M Hiremath
University/College Name	University of Agricultural Sciences Raichur, Raichur
Course Reviewer Name	Dr. Dhruv Kishor Sinha
University/college Name	Dr. Rajendra Prasad Central Agricultural University, Samastipur

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Objectives

1. To understand the concept of risk and uncertainties in agriculture and the sources of risks.
2. To study the management strategies to be followed to mitigate risk and uncertainties in agriculture.

Glossary

Risk: It is a state of uncertainty where some of the possibilities may involve undesirable outcomes. Examples are risk in production and price of agricultural commodities.

Uncertainty: It is the state of lack of certainty. Uncertainty is the state of having limited knowledge.

Price: The value expressed in terms of money

Probability: It is simply how likely something is to happen. Whenever we're unsure about the outcome of an event, we can talk about the **probabilities** of certain outcomes—how likely they are.

Hedging is a risk management strategy employed to offset losses in investments by taking an opposite position in a related asset.

1. **Concept of Risk and Uncertainty**

Agriculture is always associated with risk and uncertainty as it mainly depends upon the climatic conditions like rainfall, temperature, relative humidity etc. The definitions of risk and uncertainty were established by **Frank H. Knight** in his **1921** book, "**Risk, Uncertainty, and Profit**," where **he defines risk as a measurableprobability involving future events**, and he argues that risk will not generate profit. Risk is calculated using theoretical models, or by calculating the observed frequency of events to deduce probabilities. **Uncertainty is not quantifiable** because **future events are too unpredictable**, and information is insufficient.

Risk: It is a state of uncertainty where some of the possibilities may involve undesirable outcomes. Examples are risk in production and price of agricultural commodities.

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Uncertainty: It is the state of lack of certainty. Uncertainty is the state of having limited knowledge. Example: natural calamities such as floods, cyclones, etc. Risk can be measurable with probability concept but uncertainty cannot be measurable with probability concept.

Example: If the farmer is aware of the fact that he may not get irrigation water once in three years, then it refers the risk; whereas if he is not aware of the fact that he will get water in any particular year or not, then it refers to uncertainty (Palanisami*et al*., 2002)

2. **Types of risk and uncertainty**

1. **Production risk**: loss in outcome of the crops and livestock due to change in weather condition like rainfall, temperature, flood, incidence of pest and disease etc. These factors cannot be predicted accurately and hence results in variability of the outcomes.
2. **Technological Risk:** Another source of production risk is new technology. Will the new technology perform as expected or not? Will it actually reduce costs and increases yields? These questions must be answered before adopting new technology.
3. **Price risk or Market risk:** Marketing risk is also called as price risk therefore prices are determined due to interaction of demand and supply in the market. Production of crops and livestock is influenced by prices in the market. If there is less time lag between production and marketing activity, we could expect less price risk for agricultural commodities but it is not the case with most of the agricultural commodities. Supply is affected by due to weather risk and production risk. Demand for a commodity is mainly changing due to consumer's income, habits, tastes and preferences, export and import polices and overall, general economic measures taken up by the Govt. with regard to price stabilization. If there are less trade restrictions due to the increased demand in the foreign market, prices of commodities will be increasing. Similarly in the domestic markets, if the commodity prices were very high, prices

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would be brought under control by import policy. Thus, trade policy i.e., export-import (Exim) policy would have a greater impact on price stabilization of commodities.

4. **Financial Risk:** The financial risk increases with increased amount of borrowed money in the farm business. Such financial risk arises because of change in the interest rate, lending policy, repayment plans etc. Examples: uncertainty may be due to change in future interest rate and fiscal policies of RBI.
5. **Institutional risk:** The risk arises due to change in government rules and regulation policy. Examples: ban on export of some commodities, imposing of levy on some commodities, acreage restriction, subsidy and taxation etc.

Strategies or measures for management of risk and uncertainty in agriculture

Some farmers take more risk than others. However, all farmers use one or more measures of different types of safeguard themselves against risk and uncertainties on their farm.

1. **Selection of enterprises with low variability**: There are certain enterprises where the yield and price variability are much lower than for others. Example: wheat has much less variability in yield and price in irrigated area than potato
2. **Diversification**: the production of two or more commodities on the farm may reduce income variability. Example: cultivation of two crops, even if one crop get fails other crop will generate the income that in turn helps in minimizing the risk and uncertainty.
3. **Insurance**: Insurance is another well accepted method to safeguard against risk and uncertainty. It helps the farmers whenever used to lessen the variability in income and minimize the chance of the farm income dropping below minimum level. Example: Livestock and Crop insurance like PMFBY, WBCIS, livestock insurance scheme etc.

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4. **Contract farming or contract sale**: Agricultural production carried according to an agreement between buyers and farmers which establishes condition for the production and marketing of farm products. Example: Some specific commodities like gherkins, vegetables, etc often sign a contract with a buyer before planting or sowing season. The contract of these types removes the price risk
5. **Spreading Sale:** The marketing risk management through selling farm products at different points of time. Instead of selling the entire crop output at one time farmers prefer to sell part of the output at several times during the year. The spreading sale avoids the all the crop output at lower price of the year but also prevents the selling at higher price.
6. **Hedging**: It is risk minimizing technique. It is a technical procedure that involves trading in commodity future contracts through commodity brokers.
7. **Government price policies**: The market risk management can also be managed by some government price policies like minimum support price. The government purchases farm commodity from the farmers if the market price falls below the support price. Example: minimum support price, procurement price

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Course Name	Farm Management, Production & Resource Economics
Lesson 13	Agricultural Insurance
Content Creator Name	Dr G M Hiremath
University/College Name	University of Agricultural Sciences Raichur, Raichur
Course Reviewer Name	Dr. Dhruv Kishor Sinha
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Objectives

1. To understand the concept of crop and livestock insurance.
2. To study the different crop insurance schemes introduced in India.

Glossary

Crop insurance: is purchased by agricultural producers, including farmers, ranchers and others to protect against either the loss of their crops due to natural disasters, or the loss of revenue due to declines in the prices of agricultural commodities.

Premium: an amount above the regular or stated price

Indemnity / Compensation: security or protection against a loss or other financial burden.

Introduction

Agricultural insurance is one method by which farmers can stabilize farm income and investment and guard against disastrous effect of losses due to natural hazards or low market prices. Crop insurance not only stabilizes the farm income but also helps the farmers to initiate production activity after a bad agricultural year. It cushions the shock of crop losses by providing farmers with a minimum amount of protection.

Farming or crop production being a biological process, converting input into output carries the greatest risk in farming. This, coupled with market risk, impinges on the profits expected from farming.

Efficient risk reducing and loss management strategies such as crop insurance would enable the farmers to take substantial risks without being exposed to hardship. Access to formal risk diffusing mechanisms will induce farmers to maximize returns through adoption of riskier options. Investment in development of groundwater, purchase of exotic breeds for dairy will be encouraged due to insurability of the investment. This will help the individual to augment and increase the farm income (micro perspective) and also help to augment aggregate production in the country (macro perspective). The benefits of crop insurance vary

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depending on the nature and extent of protection provided by the scheme.

a) Genesis of Crop Insurance

The question of introducing an agriculture insurance scheme was examined soon after the Independence in 1947. Following an assurance given in this regard by the then Ministry of Food and Agriculture (MOFA) in the Central Legislature to introduce crop and cattle insurance, a special study was commissioned during 1947-48 to consider whether insurance should follow an "Individual approach" or a "Homogenous area approach". The study favoured "homogenous area approach" even as various agro-climatically homogenous areas are treated as a single unit and the individual farmers in such cases pay the same rate of premium and receive the same benefits, irrespective of their individual fortunes. In 1965, the Government introduced a Crop Insurance Bill and circulated a model scheme of crop insurance on a compulsory basis to State governments for their views. The bill provided for the Central government to frame a reinsurance scheme to cover indemnity obligations of the States. However, none of the States favoured the scheme because of the financial obligations involved in it. On receiving the reactions of the State governments, the subject was referred to an Expert Committee headed by the then Chairman, Agricultural Price Commission, in July, 1970 for full examination of the economic, administrative, financial and actuarial implications of the subject.

b) Crop Insurance Approaches

It is important to mention in the beginning that crop insurance is based on either Area approach or Individual approach. Area approach is based on "defined areas" which could be a district, a taluk, a block/a mandal or any other smaller contiguous area. The indemnity limit originally was 80 per cent, which was changed to 60 per cent, 80 per cent and 90 per cent corresponding to high, medium & low risks areas. The actual average yield / hectare for the defined area is determined on the basis of Crop Cutting Experiments (CCEs). These CCEs are the same conducted as part of General Crop Estimation Survey (GCES) in various states. If the actual

yield in CCEs of an insured crop for the defined area falls short of the specified guaranteed yield or threshold yield, all the insured farmers growing that crop in the area are entitled for claims.

The claims are calculated using the formula:

$$\frac{\text{(Guaranteed Yield - Actual Yield)}}{\text{(Guaranteed Yield)}} * \text{Sum Insured of the farmer}$$

The claims are paid to the credit institutions in the case of loanee farmers and to the individuals who insured their crops in the other cases. The credit institution would adjust the amount against the crop loan and pay the residual amount, if any, to the farmer. Area yield insurance is practically all-risk insurance. This is very important for developing countries with a large number of small farms. However, there are delays in compensation payments.

In the case of individual approach, assessment of loss is made separately for each insured farmer. It could be for each plot or for the farm as a whole (consisting of more than one plot at different locations). Individual farm-based insurance is suitable for high-value crops grown under standard practices. Liability is limited to cost of cultivation. This type of insurance provides for accurate and timely compensation. However, it involves high administrative costs.

Weather index insurance has similar advantages to those of area yield insurance. This programme provides timely compensation made on the basis of weather index, which is usually accurate. All communities whose incomes are dependent on the weather can buy this insurance. A basic disadvantage could arise due to changing weather patterns and poor density of weather stations.

Weather insurance helps ill-equipped economies deal with adverse weather conditions (65% of Indian agriculture is dependent on natural factors, especially rainfall. Drought is another major problem that farmers face). It is a solution to financial problems brought on by adverse weather conditions. This insurance covers a wide section of people and a variety of

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crops; its operational costs are low; transparent and objective calculation of weather index ; and quick settlement of claims

c) Crop Insurance Schemes in India and features: WBCIS and PMFBY

3.1. Crop Insurance Schemes in India

1. 1979-84 – Crop Insurance Scheme
2. 1985 – Comprehensive Crop Insurance Scheme
3. 1999 – NAIS
4. 2007 – Weather Based Crop Insurance Scheme
5. 2010 – MNAIS – Modified NAIS
6. 2016- PMFBY

1972-78: Different forms of experiments on agricultural insurance on a limited, ad-hoc and scattered scale started from 1972-73 when the General Insurance Corporation (GIC) of India introduced a Crop Insurance Scheme on H-4 cotton. In the same year, general insurance business was nationalized and, General Insurance Corporation of India was set up by an Act of Parliament. The new corporation took over the experimental scheme in respect of H-4 cotton. This scheme was based on "*Individual Approach*" and later included groundnut, wheat and potato.

1979-84: In the background and experience of the aforesaid experimental scheme a study was commissioned by the General Insurance Corporation of India and entrusted to Prof. V.M. Dandekar to suggest a suitable approach to be followed in the scheme. The recommendations of the study were accepted and a **Pilot Crop Insurance Scheme** was launched by the GIC in 1979, which was based on "Area Approach" for providing insurance cover against a decline in crop yield below the threshold level. The scheme covered cereals, millets, oilseeds, cotton, potato and chickpea and it was confined to loanee farmers of institutional sources on a voluntary basis.

1985-1999: This scheme was linked to short term credit and implemented based on the "homogenous area approach".

1999 onwards: The National Agricultural Insurance Scheme (NAIS) was introduced in the country from the *rabi* season of 1999-2000. Agricultural

Insurance Company of India Ltd (AIC) which was incorporated in December, 2002, and started operating from April, 2003, took over the implementation of NAIS.

3.2. Other Agricultural Insurance Schemes

Agriculture insurance in India till recently concentrated only on crop sector and confined to compensate yield loss. Recently some other insurance schemes have also come into operation in the country which goes beyond yield loss and also cover the non- crop sector. These include Farm Income Insurance Scheme, Rainfall Insurance Scheme and Livestock Insurance Scheme. All these schemes except rainfall insurance and various crop insurance schemes discussed above remained in the realm of public sector.

3.2.1. **Farm Income Insurance:** It was started on a pilot basis during 2003-04 to provide income protection to the farmers by integrating the mechanism of insuring yield as well as market risks. In this scheme the farmers' income is ensured by providing minimum guaranteed income.

3.2.2. **Livestock Insurance:** is provided by public sector insurance companies and the insurance cover is available for almost all livestock species. Normally, an animal is insured up to 100 per cent of the market value. The premium is 4 per cent of the sum insured for general public and 2.25 per cent for Integrated Rural Development Programme (IRDP) beneficiaries. The government subsidizes premium for IRDP beneficiaries.

d) Weather Based Crop Insurance Scheme (WBCIS):

The WBCIS were started during *Kharif* 2007 for financial support to the farmers in the event of crop failure.

4.1. Objectives and Features of WBCIS

- **Objectives**: This scheme provides insurance coverage and financial support to the farmers in the event of failure of crops due to Adverse Weather Incidence and subsequent crop loss.

- **Crops covered**: The scheme covers major food crops such as cereals, millets & pulses, Oilseeds and commercial / horticultural crops. Crops are selected and notified by State Governments.
- **Insurance Unit**: Depends on the availability of weather stations. Usually at tehsil / block level. Provide coverage against weather deviation from the notified standards on the basis of weather data received from the notified Automatic Weather Stations (AWSs) and Automatic Rain-gauges (ARGs
- **Risks covered**: Only parametric weather exigencies (like rainfall, temperature, humidity etc.) are covered and post harvest losses were not covered under WBCIS
- Actuarial premium rates are charged with a provision of subsidy up to 50%, which is shared by the Central and State Governments on 50 : 50 basis;
- It is compulsory for loanee farmers and optional for non-loanee farmers;
- Losses coverage in respect of hailstorm and cloud burst on individual assessment basis. Private insurance companies have been involved to provide the benefits of competition

e) Pradhan Mantri Fasal Bima Yojana (PMFBY)

The Finance Minister introduced Pradhan Mantri Fasal Bima Yojana in the Union Budget 2016 – 17. The Prime Minister Narendra Modi officially launched Pradhan Mantri Fasal Bima Yojana on **13th January 2016**. Pradhan Mantri Fasal Bima Yojana mainly replaces the two existing schemes namely **NAIS (1999) and the Modified NAIS (2010)** – National Agricultural Insurance Scheme

PMFBY is the new crop damage insurance scheme that has been approved by the Union Cabinet in January 2016 and implemented from the Kharif season same year. The scheme aims to bring 50% farmers under the scheme within 2-3 years. The new scheme also covers post harvest losses with yield loss. The scheme covers kharif, rabi crops as well

as annual commercial and horticultural crops with premium charged would be up to 2%, 1.5% and 5% of the sum insured respectively

5.1. Objectives and Features of PMFBY

Objectives of PMFBY

- As a rule, the scheme provides financial support to crop loss / damages, particularly, to the unforeseen events.
- Above all, PMFBY encourages farmers to adopt innovative and modern agricultural practices.
- Lastly, the scheme ensures Food Security, Crop Diversification and Enhanced growth in agricultural sector

5.2. Salient Features of PMFBY

Coverage of Crops: The crops covered under the scheme are Rabi, Kharif and other commercial and horticultural crops like Food Crops (Cereals, Pulses and millets), Oilseeds and Commercial and Horticultural crops

Premium rates: The Kharif crops get a premium of 2 % whereas the Rabi crops gets only 1.5 %. Subsequently, the commercial and horticultural crops gain a premium of 5%.

Unit of Insurance

- "Area Approach Basis" is the key factor of PMFBY. An affected farmer can claim his insurance based on the conditions of his environmental area.
- The Unit of Insurance is Village or Village Panchayat for major crops. On the other hand, the unit is at a higher level for minor crops

Compulsory coverage – Notified area and crops

For a notified crop in the notified area, the scheme immediately comes into action. The government makes it compulsory for the following categories of farmers

1. Farmers in the notified area with a crop Loan Account can avail the scheme sooner. These farmers are the "**Loanee Farmers**".

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2. Furthermore the government sanctions or renews the credit limit for the notified crop immediately. Eventually this happens in the particular crop season.

In short a **notified crop in a notified area gets** a complete coverage.

5.3. Inclusions and Exclusions of PMFBY

5.3.1. Inclusions:

a) **Pradhan Mantri Fasal Bima Yojana insures standing crops on notified area basis. Also, the scheme provides compensations to non – preventable risks like**

- Cyclone, Typhoon, Hurricane, in brief natural storms
- Drought and dry spells
- Pests
- Natural fire
- Flood, Landslide and lastly Lightning

b) **Prevented sowing:**

Suppose the farmer intends to sow or plant his insured crop. Later due to adverse weather conditions he is unable to do so. He shall now be eligible for an indemnity of 25% of his losses.

c) **Post – Harvest Losses**

Following the harvest, the insurance coverage is available for 14 days, provided the plants are cut and spread. Moreover, the insurance can be claimed only under the included circumstances.

5.3.2. Exclusions: On the contrary, PMFBY is not applicable to the following circumstances

- War
- Riots, theft and act of enemity
- Nuclear risks
- Destroyed by domestic or wild animals
- Malicious damage

6. Farm Machinery Insurance

Farm equipment is one of a farmer's biggest investments, sometimes the highest. That's why farm equipment insurance for tractors, combines

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and other machinery is vital—it protects from specific farm-related risks like flooding, cab glass breakage and more, providing coverage for the equipment you need to make your farm profitable.

Tractors, sprayers and other farm and ranch equipment can be covered in one of two ways

- ✓ Individually, where each piece of equipment is listed separately on the policy with its own value
- ✓ Under a blanket policy, where everything is covered up to a designated amount.

Farms have changed, so have the risks. Farming has always been an equipment-intensive business. Modern farms are using precision farming techniques with sophisticated systems that are sensitive and prone to breakdown.

The Hartford Steam Boiler Inspection and Insurance Company (**HSB**) founded in 1866 and headquartered in Hartford, Connecticut, U.S., is a global specialty insurer and reinsurer.

HSB offers customized farm equipment breakdown insurance and services designed to be integrated within insurers' farm owner's products. By insuring a portfolio of business HSB make equipment breakdown coverage more affordable than individually underwritten policies.

HSB approach offers the following advantages to farm insurers:

1. *Product Differentiation* - HSB's customized farm equipment breakdown insurance product can differentiate your farm owners' product from competitors.
2. *Risk Free Income*- HSB fully reinsures equipment breakdown loss as stated in the treaty. So the ceding commission farm insurers retain is risk free income.
3. *Affordable Premiums* - By including equipment breakdown coverage as a standard element in farm owners' policies, farm insurers can broaden coverage while keeping premiums competitive.
4. *Simplicity and Economy* - Automatically including equipment breakdown coverage eliminates the need for individual account transactions and reduces handling costs for insurers and their agents.

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5. *Valued Coverage* - Modern farms have a substantial investment in equipment and their income is very dependent upon it. Including equipment breakdown coverage is a valued addition that meets farm owners changing needs.
6. *Full Service Support* - Insurers don't need to add expense or staff to provide equipment breakdown.

Farm owners equipment breakdown coverage pays for losses such as:

1. Direct physical damage to covered equipment
2. Lost farm income arising from a covered breakdown
3. Expenses to limit loss and speed recovery
4. Loss value of spoiled products and materials due to breakdown

Equipment breakdown covers risks standard farmowners policies don't:

1. Mechanical breakdown
2. Electrical short circuits
3. Centrifugal force
4. Boiler overheating, cracking and bulging
5. Pressure vessel bulging cracking and collapse

Equipment breakdown covers a wide range of equipment such as follows:

1. Pumps for irrigation and farm animal water supply
2. Generators to power farm machinery and for back-up power
3. Farm refrigeration units
4. Boilers and pressure vessels
5. Heating and cooling systems
6. Farm water heaters
7. Mechanical equipment
8. Electrical distribution systems
9. Heating and cooling systems
10. Computers and electronic equipment
11. Stationary farm machinery, engines and motors

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Course Name	Farm Management, Production & Resource Economics
Lesson 14	Resource Economics
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Course Reviewer Name	Dr. Dhruv Kishor Sinha
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Objectives

- To understand the concept of resource economics and how it is different from agricultural economics
- To explain the different types of natural resources exist in the nature.

Glossary

Natural resource: Any source of wealth that occurs naturally, especially minerals, fossil fuels, timber, etc.

Renewable: Sustainable; able to be regrown or renewed; having an ongoing or continuous source of supply; not finite.

Depletion: is defined as a reduction in number or quantity.

Transaction costs: are expenses incurred when buying or selling a good or service

1. Concept of Resource Economics

Natural resource economics deals with the supply, demand, and allocation of the Earth's natural resources. One 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 for future generations. Resource economists study interactions between economic and natural systems, with the goal of developing a sustainable and efficient economy.

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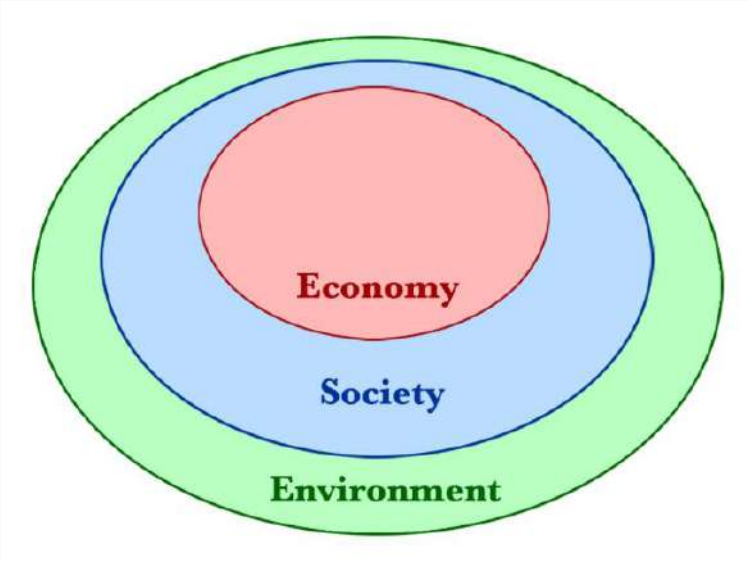

Importance of the Environment: This diagram illustrates how society and the economy are subsets of the environment. It is not possible for societal and economic systems to exist independently from the environment. For this reason, natural resource economics focuses on understanding the role of natural resources in the economy in order to develop a sufficient and sustainable economy that protects natural resources.

2. Differences between agricultural economics and natural resource economics

Particulars	Agricultural Economics	Natural Resource Economics
Main focus	Inputs - seeds, fertilizers	Resources - water, land, forests, fishery, environmental services, biodiversity
Type of cost	Marginal cost = additional cost due to additional output	Transaction cost = cost due to externality which arises due to lack of well defined property rights, lack of information
Relevance of Market Price / Value	Market price is relevant since markets for agricultural commodities are well defined	Valuation of natural resource is relevant since property rights are not definable
Market	Well defined market exists for	Well defined markets do not

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	agricultural commodities	exist for natural resource, due to lack of well defined property rights and lack of information.
Stake holders	Farmers, Consumers, Government	Virtually everyone in the society is a stake holder since natural resources are indispensable and there are no substitutes and all need them.
Policy term	Short term policies are relevant due to dynamic implications (eg. Subsidy policy, price policy, credit policy, all have short term focus)	Long term policy is a must for sustainable use of natural resources (like forest policy, water policy, land policy)
Scarcity	Scarcity of agricultural commodities is not relevant	Scarcity of natural resources is relevant due to the difficulty in their non-renewability in the short run.
Optimality rule	MR=MC	MR = MC + user cost User cost or royalty or scarcity rent = cost imposed on the future generation for using a unit of the resource now

Source: Chandrakanth, (2007)

3. Types of Natural Resources

Natural resources are derived from the environment. Some of the resources are essential to survival, while others merely satisfy societal wants. Every man-made product in an economy is composed of natural resources to some degree.

There are numerous ways to classify the types of natural resources, they include the source of origin, the state of development, and the renewability of the resources.

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In terms of the **source of origin**, natural resources can be divided into the following types:

- **Biotic:** these resources come from living and organic material, such as forests and animals, and include the materials that can be obtained them. Biotic natural resources also include fossil fuels such as coal and petroleum which are formed from organic matter that has decayed.
- **Abiotic:** these resources come from non-living and non-organic material. Examples of these resources include land, fresh water, air, and heavy metals (gold, iron, copper, silver, etc.).

Natural resources can also be categorized based on their **stage of development** including:

- **Potential resources:** these are resources that exist in a region and may be used in the future. For example, if a country has petroleum in sedimentary rocks, it is a potential resource until it is actually drilled out of the rock and put to use.
- **Actual resources:** these are resources that have been surveyed, their quantity and quality has been determined, and they are currently being used. The development of actual resources is dependent on technology.
- **Reserve resources:** this is the part of an actual resource that can be developed profitably in the future.
- **Stock resources:** these are resources that have been surveyed, but cannot be used due a lack of technology. An example of a stock resource is hydrogen.

Natural resources are also classified based on their **renewability**:

- **Renewable natural resources:** these are resources that can be replenished. Examples of renewable resources include sunlight, air, and wind. They are available continuously and their quantity is not

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noticeably affected by human consumption. However, renewable resources do not have a rapid recovery rate and are susceptible to depletion if they are overused.

- **Non-renewable natural resources:** these resources form extremely slow and do not naturally form in the environment. A resource is considered to be non-renewable when their rate of consumption exceeds the rate of recovery. Examples of non-renewable natural resources are minerals and fossil fuels.

There is constant worldwide debate regarding the allocation of natural resources. The discussions are centered around the issues of increased scarcity (resource depletion) and the exportation of natural resources as a basis for many economies (especially developed nations). The vast majority of natural resources are exhaustible which means they are available in a limited quantity and can be used up if they are not managed correctly. Natural resource economics aims to study resources in order to prevent depletion.

Natural resource utilization is regulated through the use of taxes and permits. The government and individual states determine how resources must be used and they monitor the availability and status of the resources. An example of natural resource protection is the Clean Air Act. The act was designed in 1963 to control air pollution on a national level. Regulations were established to protect the public from airborne contaminants that are hazardous to human health. The act has been revised over the years to continue to protect the quality of the air and health of the public in the United States.

4. Important properties of natural resources relevance to agriculture (Chandrakanth, 2007)

Natural resources Ex: Water, Forests, Fisheries, Land, Environment, biodiversity and their services exhibit

i. uniqueness (property of zero or low cross elasticity of substitution) (Water is unique)

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ii. indispensability (efficiency and equity implications over space, time and generations) (hence sustainability, equity are crucial)

iii. irreversibility (with varying degrees of externalities and resilience potentials)

iv. uncertainty (in information and sourcing and availability with transaction costs, imperfect info),

v. invisibility (of resources like groundwater, which renders it difficult to define property rights),

vi. remoteness (of certain flora, fauna)

vii. intricacy – complex effects over time and space (green house effect, global warming)

viii. independence to interdependency, symbiosis and synergy – can be neg, pos, zero (A+B = A+B+AB or A-B-AB or A+B-AB or A-B+AB)

ix. In the case of natural resources, no damage or zero damage is considered as a benefit

Uniqueness: This implies that there are no perfect substitutes and are required for everyone. Endangered species are unique; Unique scenic views

Irreversibility: Once natural resources are over exploited or degenerated, it is impossible to get back to their original shape or position. For instance, natural forests, once destroyed, are difficult to regain their original properties and shape; groundwater once over exploited, results in secular or long term overdraft and takes a very long time to regain the original position;

Uncertainty: If natural resources are eliminated, the society has to bear huge costs as we do not know how eco systems work, we do not know what else we are likely to lose.

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Course Name	Farm Management, Production & Resource Economics
Lesson 15	Externalities in Agriculture
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Objective

1. To understand the concept of externalities and their effects.
2. To study market failure, inefficiency and solutions for correcting inefficiency.

Glossary

Externality: An impact, positive or negative, on any party not involved in a given economic transaction or act.

Market failure: occurs when the market fails to give efficient allocation of resources.

1. Externalities in Agriculture

Externality: An externality exists when unintended side effects of one or more parties' actions affect the utility or production possibilities of one or more other parties and there is no contract between parties or price system governing the impact.

Four conditions for presence of externality

1. Action of person (B) should enter the production / consumption function of the person (A) and this Action of B is only a side effect (not main effect of B) on A
2. Action of person (B) should be unintended or should not be deliberate
3. There should be no contract between A and B governing the impact (i.e B does not have any contract or rule regarding the impact)
4. There should be no price system between parties A and B governing the impact (i.e. market fails to account the impact, which can be positive or negative or in other words, B does not pay A for inflicting the damage)

The effect of externality: Both positive and negative externalities result in (i) inefficiency and (ii) welfare loss

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All of these "hidden" costs are formally referred to by economists as externalities, **which is a cost or benefit that affects a party who did not consent to that cost or benefit;** or, **a cost or benefit of a good that is not reflected in the good's price**. There are two types of externalities; negative and positive. Externalities are not always bad things. **Negative externalities should be discouraged and positive externalities, encouraged**.

Examples:

a) Carbon emissions and soil erosion might seriously impact the lives of future generations
b) Positive externality is the practice of no-till farming, where farmers no longer pierce the ground with ploughs.
c) A beekeeping for honey production
d) Smoking: real externality because it directly impairs the health of non-smokers

2. Types of externalities:

A) Negative Externality in Agriculture

A negative externality (also called "external cost" or "external diseconomy") is an economic activity that imposes a negative effect on an unrelated third party. It can arise either during the production or the consumption of a good or service. Pollution is termed as externality because it imposes costs on people who are "external" to the producer and consumer of the polluting product

"**A negative externality would decrease the utility of third parties at external cost to them**"

For example: Air or water pollution will lower utility: either subjective displeasure or potentially explicit costs, such as higher medical expenses.

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i) **Negative production externalities:** negative externality due to production of goods and services**.** They include:

- Air pollution from burning fossil fuels. This activity causes damages to crops, (historic) buildings and public health.
- Anthropogenic climate change as a consequence of greenhouse gas emissions from the burning of fossil fuels and the rearing of livestock. It is the greatest example of market failure we have ever seen.
- Water pollution by industries that adds effluent, which harms plants, animals, and humans.
- Noise pollution during the production process, which may be mentally and psychologically disruptive.
- Systemic risk: the risks to the overall economy arising from the risks that the banking system takes.
- Negative effects of Industrial farm animal production, including "the increase in the pool of antibiotic-resistant bacteria because of the overuse of antibiotics; air quality problems; the contamination of rivers, streams, and coastal waters with concentrated animal waste; animal welfare problems, mainly as a result of the extremely close quarters in which the animals are housed."
- The depletion of the stock of fish in the ocean due to overfishing.

ii) **Negative consumption externalities**: negative externality due to consumption of goods and services. They includes:

- Noise pollution: Sleep deprivation due to a neighbour listening to loud music late at night.
- Antibiotic resistance, caused by increased usage of antibiotics. Individuals do not consider this efficacy cost when making usage decisions.

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- Passive smoking: Shared costs of declining health and vitality caused by smoking and/or alcohol abuse. Here, the "cost" is that of providing minimum social welfare.
- Traffic congestion: When more people use public roads, road users experience (congestion costs) such as more waiting in traffic and longer trip times. Increased road users also increase the likelihood of road accidents.
- Price increases: Consumption by one consumer of goods in addition to their existing supply causes prices to rise and therefore makes other consumers worse off, perhaps by preventing, reducing or delaying their consumption. These effects are sometimes called **"pecuniary externalities"** and are distinguished from **"real externalities" or "technological externalities".** Pecuniary externalities appear to be externalities, but occur within the market mechanism and are not considered to be a source of market failure or inefficiency, although they may still result in substantial harm to others

B) Positive Externality in Agriculture

A positive externality (also called "**external benefit**" or "**external economy**" or "**beneficial externality**") is the positive effect an activity imposes on an unrelated third party. Similar to a negative externality, it can arise either on the production side, or on the consumption side

On the other hand, a positive externality would increase the utility of third parties at no cost to them.

Goods with positive externalities include

- **Education**: believed to increase societal productivity and well-being, though some benefits are internalized in the form of higher wages.

- **Public health initiatives**: which may reduce the health risks and costs for third parties for such things as transmittable diseases
- **Law enforcement**.

i) **Positive production externalities**: Positive externality due to production of goods and services. They include:

- A beekeeper who keeps the bees for their honey. A side effect or externality associated with such activity is the pollination of surrounding crops by the bees.
- The construction and operation of an airport. This will benefit local businesses, because of the increased accessibility.
- An industrial company providing first aid classes for employees to increase on the job safety. This may also save lives outside the factory.
- Positive externality is the practice of no-till farming, where farmers no longer pierce the ground with plough. It reduces soil erosion and thus improves future generations' ability to feed themselves.

ii) **Positive consumption externalities:** Positive externality due to consumption of goods and services. They includes:

- An individual who maintains an attractive house may confer benefits to neighbours in the form of increased market values for their properties.
- An individual receiving a **vaccination for a communicable disease** not only decreases the likelihood of the individual's own infection, but also decreases the likelihood of others becoming infected through contact with the individual.
- Driving an electric vehicle charged by electricity from a renewable source, reducing greenhouse gas emissions and improving local air quality and public health.

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- Increased education of individuals, as this can lead to broader society benefits in the form of greater economic productivity, a lower unemployment rate, greater household mobility and higher rates of political participation.
- An individual buying a product that is interconnected in a network (e.g., a Smartphone). This will increase the usefulness of such phones to other people who have a video cell phone. When each new user of a product increases the value of the same product owned by others, the phenomenon is called a **network externality or a network effect**. **Network externalities** often have "tipping points" where, suddenly, the product reaches general acceptance and near-universal usage.

Negative externalities should be discouraged and positive externalities, encouraged.

Negative externalities in Agriculture

- Water pollution from chemical fertilizers and manure
- Exposure to pesticides
- Greenhouse gas emission
- Animal welfare problem
- Soil erosion
- Odour and Air pollution
- Antibiotic resistance etc

Positive externality in agriculture: Bee keeping, No till farming, Public health initiatives, etc

3. Market failure: inefficiency and welfare loss

Objective of an economy is to generate wealth and welfare for the society, using the available resources. These resources are scarce and there are multiple claims over them due to unlimited human wants. Market facilitates exchange and transaction of goods and service and

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seeks efficient resource allocation across alternative uses. Market failure occurs when the market fails to give efficient allocation of resources.

3.1. Causes for market failure: The main causes of market failure are as follows

i. **Incomplete markets**: Markets for certain things are incomplete or missing under perfect competition.

ii. **Indivisibilities**: Goods and factors are not infinitely divisible. Rather, they are indivisible. The problem of divisibility arises in the production of those goods and services that are used jointly by more than one person. An important example is of road in a locality.

iii. **Common Property Resources**: Common ownership when coupled with open access, would also lead to wasteful exploitation in which a user ignores the effects of his action on others. Common example is fish in a lake.

iv. **Imperfect Markets**: Efficiency of market declines under market distortions or imperfections leading to imperfect markets.

v. **Asymmetric Information**: In some cases, information about market behaviour in the future may be available but that may be insufficient or incomplete. Thus market asymmetries, fail to allocate efficiently.

vi. **Externalities**: Externalities are market imperfections where the market offers no price for service or disservice. These externalities lead to misallocation of resources and cause consumption or production to fall short of Pareto optimality.

vii. **Public Goods**: A public good is one whose consumption or use by one individual does not reduce the amount available for others. An example of a public good is water which is available to one person and is also available to others without any additional cost.

viii. **Public Bads**: There are also public bads in which one person experiencing some disutility does not diminish the disutility of another, such as air and water pollution.

ix. Poorly defined property rights

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x. High transaction cost

3.2. Some Solutions for Correcting for Market Inefficiency

a) **Asymmetric information**: it is solved by intermediaries that could provide quality and accurate information to market players i.e buyers and sellers

b) **Property Rights**: Establishing well defined, transferable, enforceable property rights can lead to efficient markets.

c) **Coasian Bargaining**: If property rights are well defined and negotiation costs are low, bargaining between (or among) individuals can lead to efficiency.

d) **Corrective Taxes**: If a tax is set equal to the marginal external cost, an efficient outcome may be produced in the case of negative externalities.

e) **Corrective Subsidies**: If a subsidy is provided equal to the marginal external benefit, an efficient outcome may result in the case of positive externalities.

f) **Direct Regulation**: Production or consumption decisions could be regulated directly in order to decrease negative externalities or increase positive externalities.

g) **Negative externalities**: the negative externalities like for example pollution can be controlled by the lawsuits that increases the opportunity cost for the polluters

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Course Name	Farm Management, Production & Resource Economics
Lesson 16	Issues in Economics and Management of Common Property Resources
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Objectives

1. To understand the issues in economics and management of common property resources.

Glossary

A common resource: is one that can provide benefit to society but which is not owned by anybody in particular.

Depletion: is an accrual accounting technique used to allocate the cost of extracting natural resources such as timber, minerals, and oil from the earth.

Open Access resources: refers to resources that are freely available for viewing and/or use. Open Access is not the same as Public Domain, and most Open Access creators do retain their copyrights.

Common property resources (environmental): are natural resources owned and managed collectively by a community or society rather than by individuals.

Forests: In a wide range of situations, people have depended on the outputs of forest resources that were best controlled and managed collectively.

INTRODUCTION

Common property resources (CPRs): Resources **accessible** to and **collectively owned**\held\managed by an **identifiable community** and on which no individual has **exclusive property rights** are called common property resources.

Common property resources refer to all such resources which are accessible to the whole community and to which no individual has

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exclusive property rights. The rights and practices determining the access to these resources are generally conventional.

In India, CPRs include village pastures and grazing grounds, village forests and woodlots, protected and unclassed government forests, waste lands, common threshing grounds, watershed drainage, ponds and tanks, rivers, rivulets, water reservoirs, canals and irrigation channels.

A resource is common property if access to it is not controlled. That is, a resource is common property if no one effectively owns the resource.

1. Common property management of land, water, forest, pasture and fish resources

Common property resources refer to all such resources which are accessible to the whole community and to which no individual has exclusive property rights. The rights and practices determining the access to these resources are generally conventional.

In India, CPRs include village pastures and grazing grounds, village forests and woodlots, protected and unclassed government forests, waste lands, common threshing grounds, watershed drainage, ponds and tanks, rivers, rivulets, water reservoirs, canals and irrigation channels.

1.1. Common village land or 'commons': These categories of CPRs refer to common property land resources within the boundary of the village and were formally (i.e. by legal sanction or official assignment) held by village panchayat or community of the village.

1.2. Categories of common village land are described below:

- **Village panchayat grazing land/pasture land**: This is a well-defined category of land in the classification used in official land-use records. Traditionally, grazing and pasture land has been the most important constituents of CPR land. Many villages have land earmarked as permanent pasture land / grazing land. These are variously known as gauchar, gochar, gairan, gomol, etc. Villagers have user right on permanent pasture by legal sanction. Village

woodlots which may have come up on the grazing land/pasture land were not considered under this category

- **Village forest & woodlot (not under Forest/Revenue Deptt.) and van panchayat forest**: This item includes all land under village forest and woodlots. This also includes the area notified as forest within the village which may belong to the forest department, or any other government department (like Revenue deptt. or PWD.) but is formally under the **management of village panchayat or a community of the village**. **Van panchayat forests** in the hills of **Uttar Pradesh**, which are formally managed by village communities
- **Village sites and threshing floor**: They include village sites and all area of land which is earmarked for common use of the villagers for economic activities, such as (a) processing of agricultural produce , (b) storing of grains, other agricultural produce, firewood, etc., (c) use for other household enterprise.

1.3. Common water resources: Typically, an Indian village uses a number of water sources, usually of different types, to meet domestic as well as agricultural needs. These sources of water are either held by the village community as a whole or constructed by or lie within jurisdiction of a government department. All these sources, whether or not controlled by a community or a local body, which are not held by individual households, have been treated as common water resources.

Community management of water resources: Management of water resources by a local body, whether formal or informal, has been referred to as community management of common water sources. Apart from local self-government (like panchayat) and formal local organisations (like **co-operative, panipanchayat, sinchaisamitis and other farmers associations**), totally informal but functionally effective local-level organizations for managing common water resources are commonly found in a large number of villages. All such informal bodies in addition to the formal bodies as forming part of community management.

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1.4. Common forest resources

A very large part of the country's natural resources was common property, in the sense that a wide variety of necessary resources was freely available to the rural population.

Community management of forest resources:

Management of forest resources by a local body, whether formal or informal, has been referred to as community management of common forest resources. The efficient management of forest resource is possible through joint forest management by local people and government organization. In some state like Uttar Pradesh and Orissa individual community were managing the forest resources. Example: **Van panchayat forests** in the hills of **Uttar Pradesh** and "**Grama Jungle**" in Orissa which are formally managed by village communities

Government forest: By legal status, forests in India are classified into following three categories, viz. **Reserved forest, Protected forest, and Unclassified forests**. Forest land also includes all state owned area of land classed as forest under any legal enactment or administered as forest, whether or not actually under forest. However, area of land under social and farm forestry, village forests, Van Panchayat forests and forests owned by individual households are excluded.

- **Reserved forest**: Reserved forests are constituted under the Indian Forest Act or other forest laws of the States. The government holds absolute rights of ownership in reserved forests. Example: all forests declared as wild life or game sanctuary or national parks
- **Protected forest**: Protected forests too are constituted under the Forest Act. The locals are permitted to gather all produce except those items which are specifically prohibited. Other privileges to the local population are also permitted.
- **Unclassed forests**: According to the classification by legal status, this category includes all other forests. Some of these forests are privately owned. All village forests are included in this category.

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Management of CPRs

- Different regimes for management of CPRs are
- Privatization,
- State ownership,
- Communal management and
- Participatory management

2. Price' or 'value' relevance for natural resources

In the case of natural resources, since the property rights are not properly definable, markets in the conventional sense cannot exist. Since markets cannot exist, the market price cannot be the representing the value of natural resource. Even if markets exist for some resources (like minerals, forest produce), they may only represent the tip of the iceberg of value equivalent to USE VALUE. But natural resources in addition have Option value, Vicarious Value, Bequest value, Existence Value and Intrinsic value which are not captured in the market. Hence 'VALUE' is relevant for natural resource rather than 'PRICE'.

Natural resource value or environmental value involves a multiplicity of values. Each type of value has its own moral standing.

Use value: or user value or user benefit is the value of benefit from the actual use of the resource at present. For example, teak timber has a use value in construction, hunter nuts a wild animal and derives an immediate benefit,

Option value: Value of a resource as a potential benefit in future. For instance during early 1970s, the plant Vincarosea was considered as a weed and had no use value. But during 1975, Vincarosea was found to have anti-carcinogenic properties through research. Due to generation of research information, the Option value increased enormously and commercial cultivation of this plant is providing livelihood to a few farmers. The roots of vincarosea are used to as anti-carcinogenic agent. If this plant were to vanish by some reason, as it is happening to several medicinal plants of the Himalayas, option value would never have been estimated.

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Vicarious value: is the value paid to preserve a resource for the benefit of others (eg. Benefit shows of worldwide fund for nature; Debt-for-nature swap programs of Green Peace, or Sierra Club in the USA, where in funds are raised from the US public, in order to pay the debts of south American countries to the world bank, in return for preservation of the Amazonian forests).

Bequest value : is the value paid to preserve a resource for the benefit of our future generation. People in their 'will' bequeath the natural resources or property to their children.

Existence value: is the value expressed by individuals which is not associated with present or future use of a resource. Example: High existence values can be seen in South Kodagu, where *Kodagas* have resisted encroachment of DevaraKadu (Sacred groves) and have preserved and maintained them exclusively for the purpose of their mere existence, may be for ecological or spiritual purposes which are not related present or future use. In North kodagu, existence value is not strong as there are encroachments in to the Devarakadu (sacred groves), and hence their existence value is relatively lower.

Intrinsic value: is the value totally unrelated to human use, and includes concern for rights and welfare of the non-human beings. For example, a rock which has no value for humans may have a large intrinsic value for a flying bird which may sit on it and relax.

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