

COURSE NAME : FARM MANAGEMENT, PRODUCTION AND RESOURCE ECONOMICS

COURSE CODE: AGS 328

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

Agricultural Economics

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

Nature and Scope of Agricultural Economics

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

Both microeconomics and macroeconomics have applications in agriculture. The production problems on individual farms are important. But agriculture is not independent of other sectors of the economy. The logic of economics is at the core of agricultural economics but it

is not the whole of agricultural economics. To effectively apply economic principles to agriculture, the economist must understand the biological nature of agricultural production. Thus, agricultural economics involves the unique blend

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

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

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

Why study production process

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

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

Agricultural Production Economics

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

choice are applied to the use of resources of land, labour, capital and management in the farming industry.

Goals of Production Economics

The following are the goals of agricultural production economics:

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

Subject Matter of Agricultural Production Economics

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

Objectives

1. To determine and outline the conditions that give the optimum use of capital, labour, land and management resources in the production of crops, livestock and allied enterprises.
1. To determine the extent to which the existing use of resources deviates from the optimum use.
1. To analyse the forces which condition the existing production pattern and resource use.
2. To explain the means and methods in getting from the existing use to optimum use of resources.

Agricultural Production Economics: Basic Concepts

1. Production: The process through which some goods and services called inputs are transformed into other goods called products or output.
2. Production function: A systematic and mathematical expression of the relationship among various quantities of inputs or input services used in the production of a commodity and the corresponding quantities of output is called a production function.
3. Continuous production function: This function arises for those inputs which can be divided into smaller doses. Continuous variables can be known from measurement, for example, seeds and fertilizers, etc.
1. Discontinuous or discrete production function: This function arises for those inputs or work units which cannot be divided into smaller units and hence are used in whole numbers. For example, number of ploughings, weeding and harvestings, etc.
2. Short run production period: The planning period during which one or more of the resources are fixed while others are variable resources. The output can be

varied only by intensive use of fixed resources. It is written as

$Y=f(X_1, X_2 / X_3.....X_n)$ where Y is output, X_1, X_2 are variable inputs and $X_3.....X_n$ are fixed inputs.

1. Long run production period: The planning period during which all the resources

can be varied. It is written as $Y=f(X_1, X_2, \dots, X_n)$

1. Technical coefficient: The amount of input per unit of output is called technical coefficient.
1. Resources: Anything that aids in production is called a resource. The resources physically enter the production process.
2. Resource services: The work done by a person, machine or livestock is called a resource service. Resources do not enter the production process physically.
1. Fixed resources: The resources that remain unchanged irrespective of the level of production are called fixed resources. For example, land, building, machinery. These resources exist only in short run. The costs associated with these resources are called fixed costs.
2. Variable resources: The resources that vary with the level of production are called variable resources. These resources exist both in short run and long run. For example, seeds, fertilizers, chemicals, etc. The costs associated with these resources are called variable costs.
3. Flow resources: The resources that cannot be stored and should be used as and when these are available. For example, services of a labourer on a particular day.
1. Stock resources: The resources that can be stored for use later on. For example, seeds. Defining an input as a flow or stock depends on the length of time under consideration. For example, tractor with 10 years life is a stock resources if we take the services of tractor for its entire useful life of 10 years. But it also provides its service every day, therefore it is a flow resources.
1. Production period: It is the time period required for the transformation of resources or inputs into products.
1. Farm entrepreneur: Farm entrepreneur is the person who organizes and operates the farm business and bears the responsibility of the outcome of the business.

2. Farm business manager: Person appointed by the entrepreneur to manage and supervise the farm business and is paid for the services rendered. He/she carries out the instructions of the entrepreneur.
1. Productivity: Output per unit of inputs is called the productivity.
1. Technical efficiency: It is the ratio of the physical output to inputs used. It implies the using of resources as effectively as possible without any wastages.
1. Economic efficiency: It is the expression of technical efficiency in monetary terms through the prices. In other words, the ratio of value of output to value of inputs is termed as economic efficiency. It implies maximization of profits per unit of input.
1. Allocative efficiency: It occurs when no possible reorganization of resources/production can make any combination higher yielding without making other combination less yielding. It refers to resource use efficiency.
1. Optimality: It is an ideal condition or situation in which costs are minimum and/or profits maximum.
1. Cost of cultivation: The expenditure incurred on all inputs and input services in raising a crop on a unit area is called cost of cultivation. It is expressed as rupees per hectare or rupees per acre.
1. Cost of production: The expenditure incurred in producing a unit quantity of output is known as cost of production, for example, Rs./kg of Rs./quintal.
1. Independent variable: Variable whose value does not depend on other variables and which influences the dependent variable, is termed as independent variable, for example, land, labour and capital.
1. Dependent variable: Variable whose value depends on other variables is termed as dependent variable, for example, crop output.
2. Slope of a line: It represents the rate of change in one variable that occurs when another variable changes. Slope varies at different points on a curve but remains same on all points on a given line. It is the rate of change in the variable on vertical axis per unit change in the variable on horizontal axis and is expressed as a number.

1. Total physical product: Total amount of output obtained by using different units of inputs measured in physical units, for example, kg, tonnes, etc.
1. Average physical product (APP): Output per unit of input on an average is termed as APP and is given by Y/X .
2. Marginal physical product: Addition to total output obtained by using the marginal unit of input and is measured as $\Delta Y/\Delta X$.

Production Functions: Meaning and Types

The production function portrays an input-output relationship. It describes the rate at which resources are transformed into products. There are numerous input-output relationships in agriculture because the rates at which the inputs are transformed into outputs will vary among soil types, animals, technologies, rainfall amount and so forth.

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

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

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

Assumptions of Production Function Analysis

- The production function is defined only for the non-negative values of inputs and outputs.

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

$$Y = b_0 x_1^b$$

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

Types of Production Functions

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

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

$$y = a_0 + bx$$

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

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

$$y = b_0 + b_1x_1 + b_2x_1^2 \text{ where } b_0, b_1, \text{ \& } b_2, \text{ are the parameters. Such PFs are quite common in}$$

fertilizer response studies.

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

i. Mitscherlich or Spillman function

i. Transcendental function

i. Translog PF

i. Constant elasticity of substitution (CES) function

Laws of Returns: Increasing, Constant and Decreasing

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

- Law of constant marginal returns (productivity),
- Law of increasing marginal returns (productivity) and
- Law of decreasing marginal returns (productivity)

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

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

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

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

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

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

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

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

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

Returns to Scale

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

Hypothetical example of returns to scale

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

Difference between the law of variable proportions and returns to scale

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

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

Farm Management: Definition, Scope and Importance

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

Definitions

- ⑩ Farm management is defined as the science that deals with organization and operation of the farm in the context of efficiency and continuous profits (**J.N. Efferson**).
- ⑩ Farm management is defined as the science of organization and management of the farm enterprises for the purpose of securing greatest continuous profits (**G.F. Warren**).
- ⑩ Farm management is defined as the art of managing a farm successfully as measured by the test of profitability (**Gray**).
- ⑩ Farm management is defined as the art of applying business and scientific principles to the organization and operation of the farm (**Andrew Boss**).

- ⑩ Farm management is the decision-making process whereby limited resources are allocated to a number of production alternatives to organize and operate the business in such a way to attain some objectives (**Ronald D. Kay**).
- ⑩ Farm management is a branch of agricultural economics, which deals with wealth earning and wealth spending activities of farmer in relation to the organization and operation of the individual farm unit for securing the maximum possible net income (**Bradford and Johnson**).
- ⑩ Farm management, as the sub-division of economics, which considers the allocation of limited resources within the individual farm, is a science of choice and decision-making and thus a field requiring studied judgment (**Heady and Jensen**).

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

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

Scope and importance of farm management

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

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

Farm Management Research

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

• FARM MANAGEMENT DECISIONS

Farmers must be able to take appropriate decisions at appropriate time. Incorrect judgement and decisions would result in the failure of execution of farm plan and in turn economic loss. The farm management decisions can be broadly categorized into two ways.

- The first method of classifications is according to the following criteria: a) Importance, b) Frequency, c) Imminence, d) Revocability and e) Alternatives available. Each of the above criteria is discussed briefly.
- Importance: Farm management decisions vary as to the degree of importance measured generally through the magnitude of profit or loss involved. For example, a decision to engage in poultry is relatively more important than a decision regarding the type and location of poultry shed.
- Frequency: Many decisions assume importance on the farm because of their high frequency and repetitive nature. The decision about what and how much to feed to the dairy animals is made more frequently than that regarding the method or time of harvesting of paddy.
- Imminence: It refers to the penalty or cost of waiting with respect to different decisions on the farm. Experience shows that while it pays to act quite promptly in some

cases, postponement is necessary in other cases till the required complete information becomes available. For example, the decision to harvest paddy is much more imminent than a decision about buying a tractor.

- **Revocability:** Some decisions can be altered at a much lower cost as compared to others. For example, it is relatively easier to replace paddy with groundnut, which perhaps becomes more profitable, than to convert a mango orchard into a sugarcane plantation.

- **Alternatives available:** The number of alternatives can also be used for classifying farm management decisions. The decisions become more complicated as the number of alternatives increase. For example, threshing of paddy can be done manually or with thresher.

Classification of decisions based on the above criteria is not mutually exclusive and is changing from individual to individual and from place to place for the same individual.

- The second method classifies farm management decisions into: a) what to produce? b) when to produce? c) how much to produce? and d) how to produce?

The farm manager should choose the enterprises based on availability of resources on the farms and expected profitability of the enterprise. This is studied through product-product relationship. Once the farmer decides on what to produce, he must also decide on when to produce, as most of the agricultural commodities are season bound in nature. Then, he should decide how much of each enterprise to produce, since the supply of agricultural inputs is limited. This can be studied through factor-product relationship. In order to minimize the cost of production, i.e., decisions relating to how to produce, factor-factor relationship has to be studied. The farm manager should also take marketing decisions like a) what to buy? b) when to buy? c) how much to buy? d) how to buy? e) what to sell? f) when to sell? g) how much to sell? and h) how to sell?

- **Factors Influencing Farm Management Decisions:** Farm management decisions continuously undergo a change overtime because of the changing environment around the farm, farmer and his family. The factors which influence the decision making process are:

- Economic factors like prices of factors and products.

- Biological characteristics of plants and animals.
- Technological factors like technological advancements in the field of agriculture and suitability of different varieties and farm practices to varied agro - climatic conditions.
- Institutional factors like availability of infrastructural facilities which include storage, processing, grading, transport, marketing of inputs and outputs, etc, government policies on farm practices, input subsidies, taxes, export and import, marketing, procurement of produces and so on.
- Personal factors like customs, attitude, awareness, personal capabilities and so on.

One or more changes of the above categories in the environment around the farmer may cause imperfections in decision-making. The process of decision making, therefore, has to be dynamic so as to adjust in such changes.

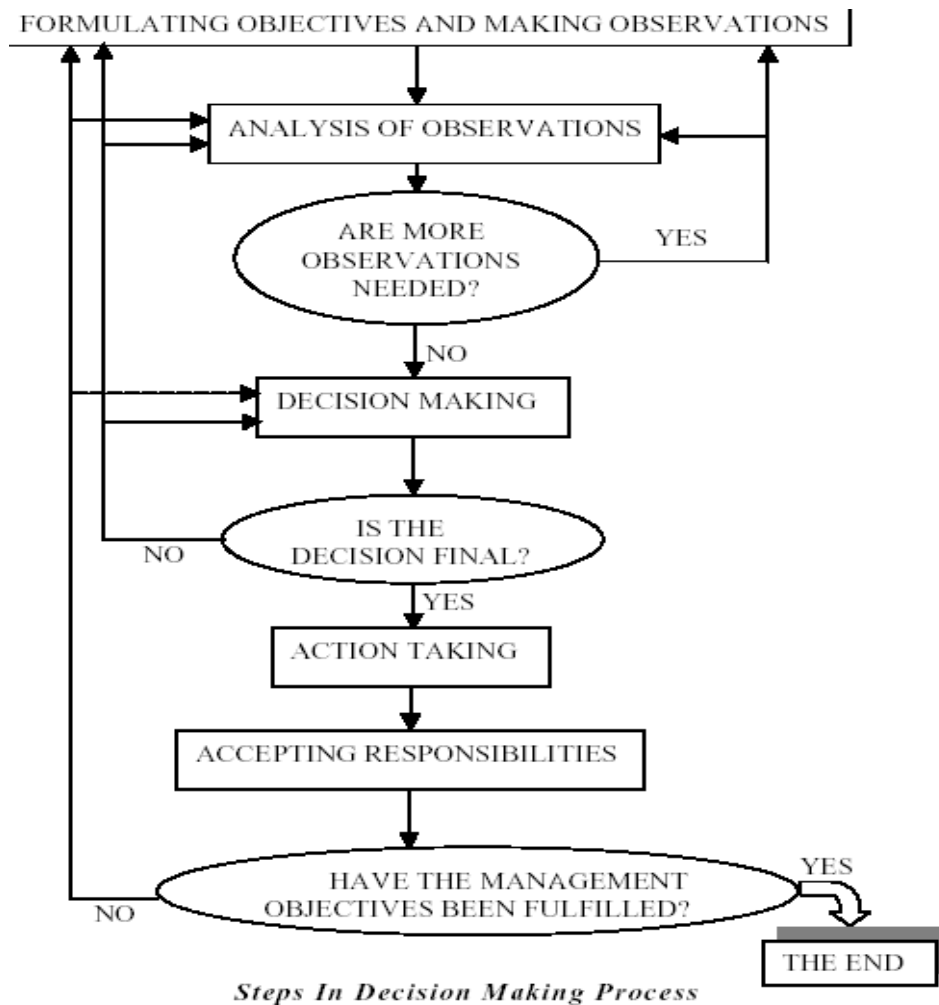
- Decision Making Process

Every farmer has to make decisions about his farm organization and operation from time to time. Decisions on the farms are often made by the following three methods:

- Traditional method: In this method, the decision is influenced by traditions in the family or region or community.
- Technical method: In this method, the decisions require the use of technical knowledge. For example, a decision is to be made about the quantity of nitrogen requirement to obtain maximum yield of paddy.
- Economic method: All the problems are considered in relation to the expected costs and returns. This method is undoubtedly the most useful of all the methods for taking a decision on a farm.

- Steps in Decision Making

The steps in decision - making can also be shown schematically through a flow chart. The important steps involved in the decision-making process are formulating objectives and making observations, analyses of observations, decision-making, action taking or execution of the decisions and accepting the responsibilities. The evaluation and monitoring should be done at each and every stage of the decision making process.



- Functions of a Farm Manager: Some of the major areas, which form the subject matter of farm management, are listed below:
 - Farm Management Functions: The major farm management functions are:
 - Selection of enterprises.
 - Organization of agricultural resources and farm enterprises so as to make a complete farm unit.
 - Determination of the most efficient method of production for each selected enterprises.
 - Management of capital and financing the farm business.
 - Maintenance of farm records and accounts and determination of various efficiency parameters.
 - Efficient marketing of farm products and purchasing of input supplies.
 - Adjustments against time and uncertainty elements on farm production and purchasing of input supplies.

- Evaluation of agricultural policies of the government.

Farm management decision making process ? Production, operational, strategic, administrative and marketing management decisions.

- Farm management functions indicates that the farm management decisions or functions can be categorized into production, administration and marketing functions as depicted in the chart.

- **Production and Organization Decisions:** The farm manager has to take vital decisions on production of enterprises and organization of his business. His decisions centre on what to produce and how to produce. Such decisions can be further classified into i) strategic and ii) operational decisions.

i. **Strategic Management Decisions:** These are the management decisions, which involve heavy investment and have long lasting effect. These decisions give shape to overall organization of the business.

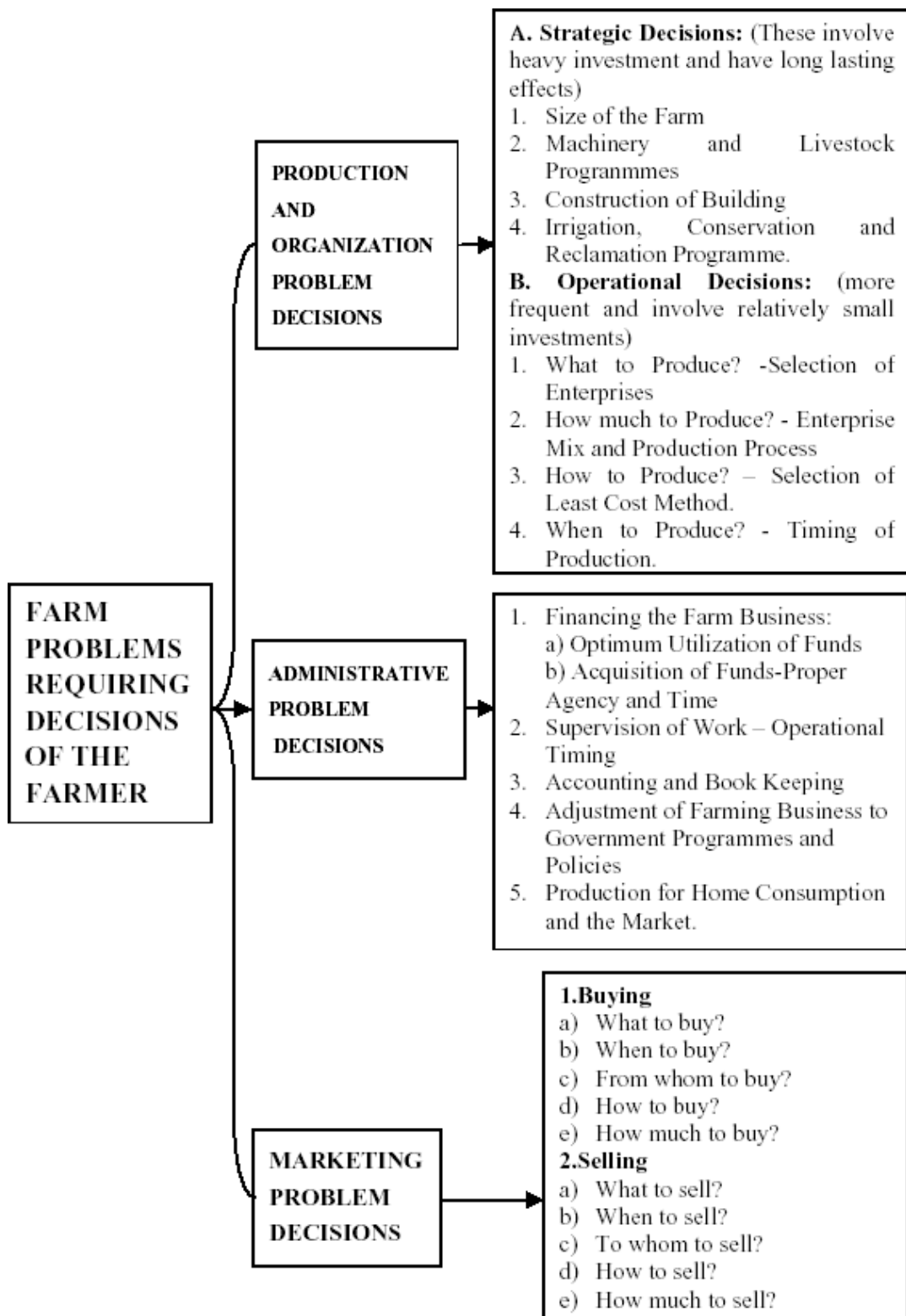
- **Deciding the best size of the farm:** The size of farm depends upon type of farm business, irrigation potential, level of mechanization, intensity of usage of land and managerial ability of the farmer. The economic efficiency of each crop/or live stock enterprise and their combinations, when they are operated on different scales, are considered to decide upon the optimum size of the holding.

- **Decisions on farm labour and machinery programmes:** Deciding the most profitable combination of the factors to be used in producing a commodity is one of the important farm management decisions. What combination of farm labour and machinery should be adopted to get maximum returns? Would it be profitable to vary labour or land to better utilize a given set of machinery? These decisions are to be taken so as to reduce the cost of production.

- **Decisions on construction of buildings:** Decisions on size and type of buildings involve heavy investment, which become fixed resource for the business. Type of buildings, for the present pattern and level of production depends upon the kind and level of crops or livestock produced.

- **Decisions regarding irrigation, conservation and reclamation programmes:** As improvements of alkalinity, salinity and other soil defects require heavy investments, soil conservation and reclamation programmes often have to be spread over years. The choice of

most economical method or a combination of methods of reclamation has to be made from among mulching, contouring, bunding, terracing and application of soil amendments, laying down of proper drainage and so on. Decision on irrigation programme is also very crucial



Farm Management Decisions

because

it involves heavy investment and it gives a flow service over long period of time and also improves the productivity of other related inputs.

- **Operational Management Decisions:** Operational management decisions are continuously made to carry out the day-to-day operations of the farm business. The

investment involved in such decisions is relatively small and hence, the impact of such decisions is short-lived. These decisions are generally: i) what to produce? ii) how much to produce? how to produce? and when to produce? A brief discussion is made on these decisions below:

- **What to produce? (Selection of enterprises):** The objective of the farm business, i.e., maximization of returns, could be achieved through the best combination of different enterprises. The relative profitability of these enterprises will be useful to determine what to produce and what not to produce.
- **How much to produce? (Enterprise mix):** This decision has two aspects: Enterprise mix and resource use.
 - **Enterprise Mix:** Combination of crop and livestock enterprises will depend upon the level of resources available, fertility of the soil, prices of factors and products in addition to the existence of complementary and supplementary relationship. Principle of substitution is used to decide the level of each enterprise, i.e., the scarce farm resources are first used for the most profitable enterprise and then the next best profitable enterprise is considered for inclusion. However, apart from profitability of each enterprise, factors like labour availability for each enterprise, size of land holding, use of by-products, maintenance of soil fertility, relative risks, distribution of incomes over time and efficiency in the use of machine power and building are considered to decide the level of each enterprise.
 - **Resource Use:** The best combination and optimum level of inputs can be determined based on the substitution principle and these have to be decided for minimizing the cost of production and maximization of returns.
- **How to produce? (Selection of least - cost / efficient method or practice):** Decisions, here, are made on the best practice or combination of practices and methods, which involve the least cost. The choice making from among the various alternatives has become a management problem. Although the objective generally is to select the least cost combination of inputs methods, consideration has to be given on the availability of resources in required quality and quantity at right time.
- **When to produce? (Timing of production):** Since the agricultural production is season-bound, it's timing has to be properly decided. However, farmer faces difficulty in selecting season, i.e., normal, early or late, for a particular crop due to non-availability of inputs in time and as a result he could not fetch maximum price for the produce.
- **Administrative Decisions**

Along with production and organization decision, the former has to see that the work is done in a right way. Such administrative decisions are briefly discussed below:

- **Financing the farm business:** While some farmers have their own sufficient funds, others may have to borrow. The problem is two fold, viz., a) utilization of funds within the farm business, and b) acquisition of funds, i.e., proper agency, time, type, and terms of credit. Cash flow analysis would be used to decide the timing and quantum of credit required.
- **Supervision of work:** The farm manager has to ensure that each job is scrupulously done as planned.
- **Accounting and book keeping:** Collection, analysis and evaluation of data have to be done in order to assess the performance of the farm at any point of time. Here decision is to be made on the kinds of farm records, time allocation and money to be spent on this activity.
- v) **Adjustments to government programmes and policies:** Government programmes and policies on food zones, restriction on product movements, price support policy, input subsidy, etc. influence farm production and marketing. The farmer has to decide on the level of production and resource-use with the maximum economic efficiency at the farm level consistent with the government policies concerned.

• **Marketing Decisions**

A farm manager has to buy various farm inputs and sell out the produces in which he has to take rational decisions. While purchasing inputs he has to consider the following aspects: a) what to buy? b) when to buy? c) from whom to buy? d) how to buy? and e) how much to buy? Similarly, in selling out the farm produces he has to carefully ponder over the following points in order to maximize his farm income: a) what to sell? b) when to sell? c) to whom to sell? d) how to sell? and e) how much to sell?

• **Relationship between Farm Management and Other Sciences**

Farm management is an integral part of agricultural production economics. Farm management is an intra farm science whereas agricultural production economics is an inter farm or inter region science. The distinction sometimes made between production economics and farm management is based on macro and micro level contents respectively. In so far as various agricultural economic problems regarding agricultural finance, land tenure, marketing, etc, are concerned at farm

level, the field of specialization related to each problem becomes an integral part of farm management.

Farm management is closely related with other social sciences like psychology and sociology (Fig.1). Farmer's ability to bear risk and uncertainty is influenced by his

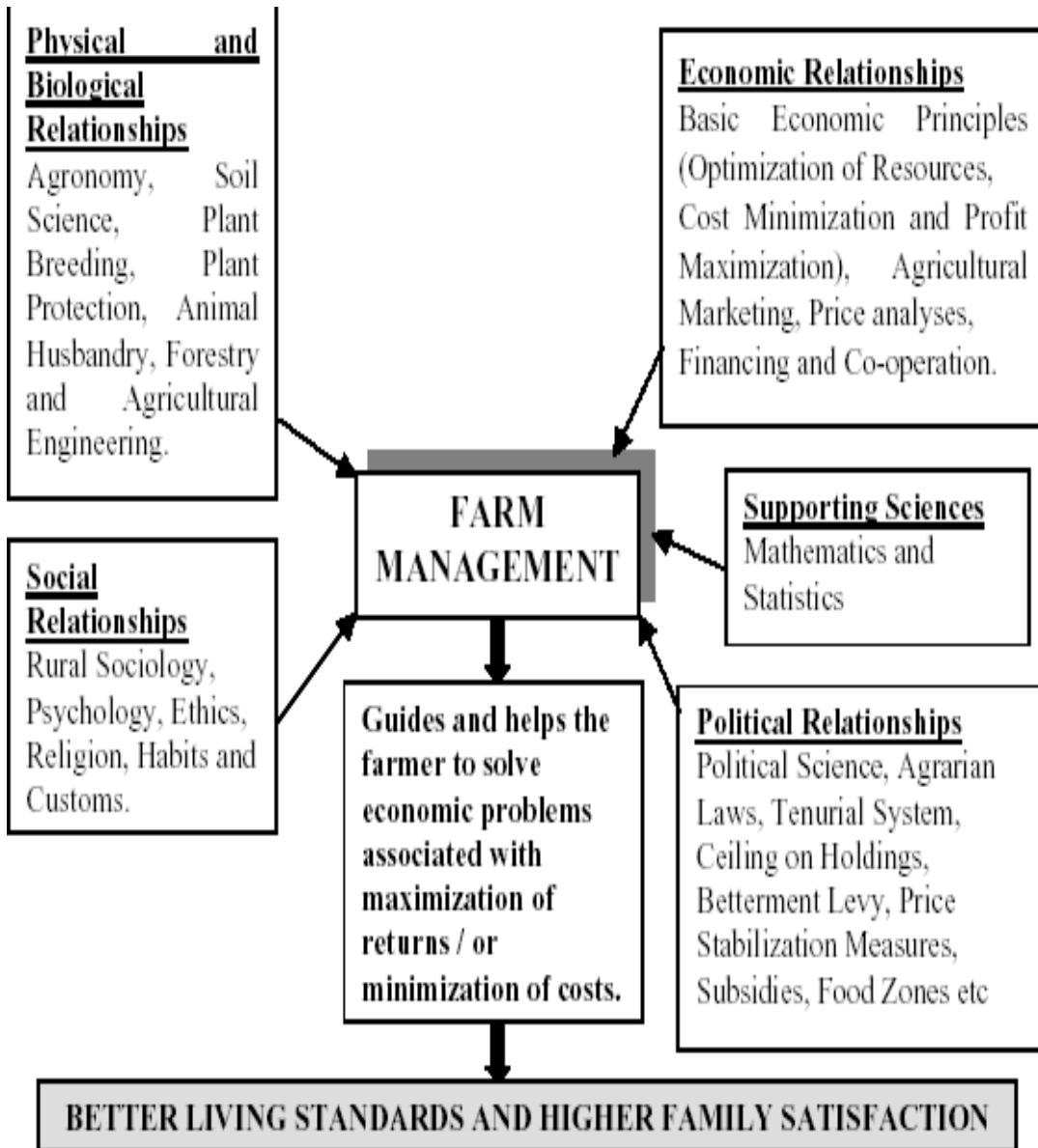


Fig.1 Relationship between Farm Management and Other Sciences psychological characteristics. His decisions are also influenced by the customs, habits and cultural values of the society in which he lives. The acceptance of new production techniques and methods in farming is influenced by political decisions of the government like restriction or encouragement of growing of crops, ceiling on land holding, price policies, etc.

Statistics is another science that helps in providing methods and procedures by which data regarding specific farm problems can be collected, analyzed and evaluated.

Farm management relies closely on other branches of agricultural sciences such as agronomy, soil science, plant protection studies, animal husbandry, agricultural engineering, forestry, etc. These physical and biological sciences are not directly concerned with economic efficiency. They provide input-output relationships in their respective areas in physical terms, i.e., they define production possibilities within which various choices can be made. It is the task of the farm management specialist and agricultural economist to determine how and to what extent the findings of these sciences should be used in farm business management.

• **Characteristics of Farming as Business:** Farming as a business has many distinguishing features from most of other industries in their management methods and practices. The major differences between farming and other industries are:

- Agricultural production is biological in nature.
- Agricultural production heavily depends on agro-climatic conditions.
- Agricultural production is carried out mostly in small - sized holdings.
- Frequent and speedy decisions are to be taken up in agricultural production. For instance, there is no time to consider the merits of paying more wages to drain the field when there is a sudden monsoon flood.
- Agricultural prices and production usually move in opposite direction.
- Lack of standardization of practices and products: By the use of machines and trained personnel, it is possible to produce large volume of products exactly the same in size, form and quality. Such standardization of practices and products is not possible in agriculture. Grading system for agricultural commodities is also very weak.
- Slow turn-over: It takes long time to recover the investment.
- Farm financing is more risky due to drought, pest and disease attack, yield variations, etc.
- The proportion of fixed cost is more in agriculture and so adjustment and substitution of resources are more difficult.
- Inelastic income demand for farm products: As income increases, the demand for agricultural products will increase in lesser proportion when compared with industrial goods.

- Perishable and bulky nature of agricultural commodities cause storage, processing and transportation problems.
- Lack of Knowledge: All farmers do not know the latest developments in agricultural technologies.
- Agricultural markets are not regulated properly and there are too many middlemen in the agricultural marketing system, whereas in industry, the distribution channels are well defined and controlled by producers.
- Agriculture is considered not only a means of livelihood but also a way of life to the farmers in all the under developed countries.

- Farm Management Problems under Indian Conditions

Farm management problems in India vary from place to place depending mostly on the degree of infrastructural development and the availability of resources. The following are some of the most common problems in the field of farm management:

- Small size of farm business: The average size of operational holding in India was 1.55 ha in 1990-91. The holdings are fragmented, too. Unfavourable land man ratio due to excessive family labour depending upon agriculture have weakened the financial position of the farmers and limited the scope for farm business expansion.
 - Farm as a household: In most parts of the country, farmers, especially dry land farmers, follow the traditional combinations of crops and methods of cultivation. Work habits are closely associated with food commodities consumed and living conditions. Farm has become the means of livelihood of farmers and hence, subsistence farming is followed. Home management, thus, heavily influences and gets influenced by farm management decisions.
 - Inadequate capital: The new technology demands costlier inputs such as fertilizer, plant protection measures, irrigation and high yielding variety seeds as well as investment on power and machinery. But perpetual debt and low marketable surplus prevent the farmers from adopting new technologies.
- 4) Under employment: Unemployment results from
- 1) small size of farm,
 - 2) large supply of family labour,
 - 3) seasonal nature of production and
 - 4) lack of subsidiary or supporting rural industries. It reduces efficiency and productivity of rural manpower.
- Slow adoption innovations: Small farmers are usually conservative and sometimes skeptical of new techniques and methods. However, once they try a new idea and find it effective, they are eager to adopt that. The rate of adoption, however, depends on farmer's willingness and his ability to use the new information.

- Inadequacy of input supplies: Farmers may be willing to introduce change, yet they may face the difficulty in obtaining the required inputs of proper quality, in sufficient quantity and on time in order to sustain the introduced changes.
- Lack of managerial skill: Due to lack of managerial skill among small farmers, adoption of new techniques and use of costly inputs could not be followed up by them.
- Lack of infrastructural facilities: Infrastructural facilities such as marketing, transport, and communication are either inadequate or inefficient and this results in the shortage of capital and quality inputs and non-availability of inputs in time.

Economic Principles applied to the Organization of Farm Business

1. Cost Principle

$$TC = VC + FC$$

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

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

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

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

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

Added returns > Added costs

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

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

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

Marginal Return to capital on these enterprises are

		Marginal Return (MR) (Rs)		
Capital used (Rs)		Crops	Dairy	Poultry
1000		1300	1400	1500
2000		1300	1200	1250
3000		1200	1100	1100
4000		1200	900	1000
5000		1100	800	900
Total Return		6100	5400	5750
from Rs				
5000				
Net Returns		1100	400	750
Av.	Returns	1.22	1.08	1.15
used/rupee				
Invested				
The marginal return will however dictate spending as				
		Amt	Enterprises	Add Return
1 st		1000	Poultry	1500

2 nd		1000		Dairy	1400
3 rd		1000		Crops	1300
4 th		1000		Crops	1300
5 th		1000			1250
TR from		5000			6750

4. Opportunity Cost Principle:

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

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

5. Time Comparison Principle

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

1. Earning power of money: represented by opportunity cost of money (rate of interest)
1. Inflation – purchasing power of money varies inversely with the price level. A rupee earned a year from now is less valuable than a rupee earned today.

1. Uncertainty: Investment deals with future & future is uncertain. Investments are made with the expectation of receiving a stream of benefits in the future.

Farm Planning and Budgeting

A) Farm planning

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

Importance of farm planning to farmer

It helps the farmers in the following manner:

1. Choose different farm activities suited to the given farm conditions.
1. Look into the future and decide on suitable course of action.
1. Select appropriate enterprise combinations that results in the better use of resources.
1. Timing various jobs and operations for smooth conduct of operations without competition.
1. Avoid wastages that occur in the resource use.

1. Provide guidance and flexibility for ensuring better use and growth of the farm business.

1. Provide allocation of resources for producing the requisite products for marketing and household consumption.

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

Objective of farm planning

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

Types of farm plans

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

Characteristics of good farm plan

The following are the characteristics of a good farm plan:

1. Plans should aim at efficient utilization of all the available resources on the farm.

1. Plans should be flexible i.e., they should be adaptable to changing environmental conditions.

1. Farm plans should be simple and easily understood.

1. Considering the available resources, farm plans should ensure balanced production programme consisting of food crops, commercial crops and fodder crops.

2. The production programme included in the farm plan should aim at improving soil fertility.

1. Farm plans should facilitate efficient marketing of farm products.

1. It should take into account up-to-date technology.

1. Farm plans should consider the goals, knowledge, training and experience of the farmers, and their attitude towards risk.

1. Farm plans should avoid too risky enterprises.

1. Farm plans should provide for borrowing, using and repaying the credit.

Limitations of farm planning

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

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

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

B) Farm budgeting

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

1. Farm enterprise budget

Commodity production on the farm is called farm enterprise. Farm budgets can be developed for each potential enterprise. Enterprise budgets are prepared in terms of a common unit i.e.,

acre, hectare, for a crop, one head of livestock, etc. This facilitates easy comparison among the enterprises. Enterprise budget is the estimation of expected income, costs and profit for an enterprise.

Organization of enterprise budget

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

Table: Enterprise Budget for Pea

Sr. No	Particulars	Per bigha			Per ha	
		Quantity	Rate(₹)	Value(₹)	Quantity	Value (₹)
A	Variable cost					
1	Seed (kg)	22	33	726	275	9075
2	Seed treatment			18		225
3	FYM (q)	7.50	162	1215	93.75	15187.5
4	Fertilizers					
i)	IFFCO mixture (kg)	13	10.70	139.10	162.50	1738.75
ii)	Urea (kg)	6	6	36	75	450
5	Plant protection			418		5225
6	Bullock labour (days)	2	500	1000	25	12500
7	Human Labour (man days)					
i)	Field preparation	3	150	450	37.50	5625
ii)	Seed preparation & sowing	3	150	450	37.50	5625
iii)	Manuring	3	150	450	37.50	5625
iv)	Interculture	11	150	1650	137.50	20625
v)	Irrigation	4	150	600	50	7500
vi)	Spraying	3	150	450	37.50	5625
vii)	Harvesting/Picking, packing & transportation	7	150	1050	87.50	13125
viii)	Total human labour of which	34		5100	425	63750
i)	Family labour	22	150	3300	275	41250
ii)	Hired Labour	12	150	1800	150	22500
8	Sub total (1 to 7)			8652.10		108151.3
9	Interest on working capital			115.36		1442.02
10	Total variable cost(A=8+9)			8767.46		109593.3
B	Fixed cost					

i)	Rental value of land		5000		62500
ii)	Interest on fixed capital		648		8100
iii)	Depreciation		810		10125
	Total fixed cost		6458		80725
C	Total cost (A+B)		15225.46		190318.3
D	Production and Returns				
1	Production (q)		10.75		134.375
2	Average price (₹/kg)		22		22
3	By product (q)		1.02		12.75
4	Average price (₹/kg)		15		15
5	Gross Returns		25180		314750
6	Net Returns (₹)		9954.54		124431.70

2. Partial budgeting

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

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

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

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

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

3. Complete Budgeting

It is a method of estimating expected income, expense and profits for the farm as whole.

Complete budgeting is employed when farmers want to overhaul the entire farm business.

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

1. Statement of objective.

1. Diagnosis of the existing organization

1. Assessment of resource endowments on the farm.

1. Identification of enterprises to be included.

- Preparation of enterprise budgets.

- Identification of risks, and

- Preparation of a plan.

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

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

1. Assessment of resource endowment on the farm:

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

a. Labour: The extent of family labour available with the farmer viz., women, men and children along with their age, household work and farm work done by them should be

indicated. Permanent labourers if any engaged by the farmer, type of work done and amount of remuneration paid should be indicated. Labour supply, in the village and demand for labour for different crops in different seasons should be assessed. The supply position with reference to livestock should be assessed correctly.

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

Fixed capital relates to information on farm buildings, farm equipment, farm machinery, etc.

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

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

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

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

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

1. Identification of risks: List out all types of risks viz., production risk, weather risk, technological risk, institutional risk, marketing risk, etc., faced by the farmers. Particularly the incidence of pests, rodents and diseases, frequency of drought occurrence over time, cyclones, floods and their havoc caused to farm plans. Marketing risks comprising of risk

emanating from price fluctuations and failure of markets to arrest the malpractices of middlemen should be indicated.

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

Risk

Knowledge situation

Risk and Uncertainty

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

	Perfect			Imperfect		
	knowledge			Knowledge		

Uncertainty

A priori		Statistical

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

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

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

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

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

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

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

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

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

of the produce.

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

1. Personal uncertainties

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

Safeguards against risk and uncertainty

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

1. Selection of enterprises with low variability

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

2. Discounting returns

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

3. Insurance

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

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

4. Forward contracts

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

5. Flexibility

This refers to the convenience with which the organization of production on a farm can be changed. Some organizations are obviously more flexible than others and flexibility in an organization through change in production helps obtaining advantages and improvements in the economic and technological environment of a farmer. As an uncertainty safeguard, flexibility may be built into farm plan for stabilization of incomes from year to year and to

maximize the expected stream of total income over a longer period of time. It differs from diversification in the sense that it aims at preventing the sacrifice of large gains as compared to the prevention of large losses through diversification.

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

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

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

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

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

6. Liquidity and asset management

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

7. Diversification

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

Linear Programming

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

Components of LP problem

There are three quantitative components in LP model. They are

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

Assumptions of LP problem

There are seven basic assumptions:

1. Linearity of the objective function
1. Divisibility of the activities as well as resources
1. Additivity of the resources and activities

1. Finiteness of the activities and resource restrictions

1. Single value expectations

1. Non-negativity of the decision variables and

1. Proportionality of activities to resources

1. Linearity of the objective function: All the decision variables in the objective function, i.e., crop and livestock activities are in linear form (without power form) and the objective function is also linear, for example, as $\pi = 250 X_1 + 350 X_2 + 500 X_3 + \dots + 400 X_n$. The coefficients of X_1 are the net returns/ prices of the crops and livestock.

1. Divisibility of the activities as well as resources: Continuity of resources and output is implied in this assumption. This means fractional quantities such as 0.2 ha of land and 3.5 qtl of paddy etc., are allowed. But divisibility for livestock activities and labour resources appears to be unrealistic. To get integer values for such livestock activities, an integer programming is being used.

1. Additivity of the resources and activities: It is the reciprocal of divisibility. This assumption implies that the total quantity of a resource used must be equal to the total quantity of resource used by each activity for all resources individually and collectively. This means the activities and resources must be additive in the sense that when two or more activities are followed their total product must be equal to the sum of their individual products and the total resources used equal to the sum of resources used by individual activity. If the resource is used up fully, it should equal the sum of the same resources used by all the activities appearing in the optimal solution.

2. Finiteness of the activities and resource restrictions: With the advent of computers and availability of programmes, a large numbers of activities and constraints are now being specified in the model. But, there should be a limit for such numbers, because infinite number of activities and resource restrictions cannot be accommodated in the model. Hence, this assumption is important in the LP model. In general, it is desired to have more number of the activities than the constraints in LP model.

1. Single value expectations: This assumption connotes certainty assumption and imparts

to the LP model, the name of deterministic model. According to this assumption, input-output coefficients (a_{ij}), resource availabilities (B_j) and prices of activities (C_j), all are specified correctly with known quantities in the model and they all relate to a particular period of time. In the risk programming models this assumption is relaxed.

1. Non-negativity of the decision variables: All the crops and livestock activities should have positive values in their magnitude. Negative values for such decision variables cannot make any sense. Hence, this assumption is imperative.

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

Basic Concepts in LP

- **Goals of the Programming Model:** Programming model guides the farmers to specify the farm plans which will give him maximum income under the given constraints, prices, yields and resource requirements. Cost minimization in the cattle feeding problems, poultry feeding problems and transportation models, is considered in the objective function of LP model.
- **Activity or Process:** The word activity is used to refer to crop and livestock enterprises being undertaken. A typical method of production with specific resources requirement in crops and livestock is referred to as a process or activity. Based on this concept, crops or livestock activities are delineated into separate or individual activities in the model. For example, local paddy crop requiring different levels of inputs for obtaining various output levels are treated as separate activities. Similarly, if two cows of the same breed are reared on different rations, they can be taken as separate activities in the model. A process is a method of converting a resource into a product with specified input-output relationship. This is also often referred to as technical coefficient.
- **Types of activities:** These are: (i) real activities, (ii) intermediate activities, (iii) purchasing, (iv) selling and (v) borrowing activities.
- Paddy, sugarcane, poultry eggs, milch cattle, etc., are real activities because they are produced on the farm for sale in the market. Real activities are also called decision

variables, which are specified, in the object function on the LP problem. The optimal solution indicates the magnitudes of real activities and hence they are called decision variables.

- Fodder, though produced on the farm and if not sold in the market, it cannot become real activity, so it is intermediate activity.
- Purchasing activities means the inputs like fertilizers and pesticides, which are purchased from the market and used in the production process.
- Selling activities represent the sale of products produced on the farm.
- To supplement owned funds, depending on the need, borrowing activity is included in the LP model
- Prices for products and resources are to be ascertained with certainty. Too high or too low prices will distort the income estimates and thereby profit, often leading to results of unrealistic magnitude. In general, the average prices, pooled over three to five years are considered for LP model.
- **Restrictions:** These are also called limitations or constraints. Land, labour and capital are generally considered as restraints. In the development of models for obtaining realistic results, sometimes 150 to 200 restraints are also considered by researchers in economic studies. In general, macro level studies will have more constraints than micro level studies, because of the complexities involved in macro level situation. At micro level the farmers may have restrictions regarding number of livestock animals, crop acreages, etc. Amount of labour availability during peak season of the crop growth is generally considered as the most common restriction seen in the LP model. Likewise, a farmer may have access to limited quantities of many resources. The availability and requirements in respect of machine labour, bullock labour, hired human labour, family labour, skilled labour, unskilled labour, etc., in different time periods, i.e., a week, a month, a season and a year may be considered in the programming model as separate restrictions or constraints. All these restrictions can be specified in the model in three types, i.e., greater than equal to constraints or less than equal to constraints, or equal to or equality constraints.

- **Feasible Solution:** Any solution to a linear programming problem is said to be feasible if none of the x_{js} is negative. Thus, it is a solution in which the values of the variables (ordinary and slack) satisfy both the constraints and the non-negativity restrictions. Such a solution can only be found in the first quadrant. There is no guarantee that all linear programming problems will have feasible solutions.
 - **Unfeasible Solution:** It refers to a solution wherein some of the variables, x_{js} , appear at a negative level. Obviously, therefore, a solution to a linear programming problem does not satisfy the non-negativity restrictions.
1. **Basic Solution:** The values of the variables in which the number of non-zero-valued variables is equal to the number of constraints is called basic solution. Of the basic solutions to a problem, there will be an optimal solution that satisfies the above criterion.
 1. **Optimum Solution:** Unless alternate optima for a linear programming problem occur, one of the feasible solutions is optimum, provided a feasible solution exists. Such a feasible solution which also optimises the objective function is called an optimum solution. The set of x_{js} in this case satisfies the set of constraints and non-negativity restrictions and also maximizes the objective function.
 1. **Unbounded Solution:** Many a time, faulty formulation of a linear programming problem may result in a arbitrarily large value of the objective function and the problem has no finite maximum value of π . It may require only one or more variables to assume arbitrary large magnitudes. This represents a case of an unbounded solution to a linear programming problem.