FARM MANAGEMENT

HAND-BOOK

Guillermo Guerra

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FOREWORD

This book succeeds very well in filling a need for literature on agricultural economics in Latin America and the Caribbean.

Although our historical and geographic background has created a socio-economic and biological situation substantially different from that which exists in the more developed countries, we have persisted in our attempts to transplant their ideas and institutions, and had much less success than anticipated. Scientific research, upon which agricultural and livestock production is based, originates almost exclusively from centers located in temperate climates and is inapplicable or of little use in tropical conditions.

Moreover, technology oriented toward taking maximum advantage of scarce labor with abundant land and capital resources —a situation typical of the more developed world— frequently tends to aggravate the problems of rural Latin America instead of alleviating them. A diametrically opposed focus is needed. It is necessary to find ways of producing large quantities of food on small areas of land, purchasing few inputs and making use of unemployed laborers. All of this must take place within an institutional apparatus currently in desperate need of immediate modernization.

An agricultural enterprise must be efficient whatever its size, but the management of the business will be more effective when knowledge and rational use of resources are combined. We must seek associative business practices which will permit a rational use of labor and management; this is the reason for our concern with the establishment of community enterprises and the management standards they need.

It is necessary to discover fundamental and universally valid concepts, strip away their deceptively local trappings, and use them as a basis for the reconstruction of their forms of expression, using indigenous elements and adapting them to the reality of our countries. The task is difficult and requires solid professional knowledge, broad judgement, and considerable experience. Guillermo Guerra fully satisfies *these requirements. In his twenty years of professional experience since his completion of the Agronomy degree from the National University in Colombia, he has undertaken a wide range of activities. He did special studies in agricultural economics, first in Peru and in Uruguay with the Inter-American Institute of Agricultural Sciences and later at the University of Arizona, USA, where he obtained his Masters Degree. He has been a professor, researcher, and Head of the Agricultural Economics Department of the Agronomy Faculty of the National University of Colombia in Medellín. Also, he has broad experience teaching agricultural economics for the Inter-American Institute of Agricultural Sciences – now the Inter-American Institute for Cooperation on Agriculture – and training for the preparation and evaluation of agricultural development projects. As Secretary of Agriculture of the Department of Antioquia and as Economic Advisor to the Ministry of Agriculture in Colombia, he participated in defining and implementing agricultural and livestock policy at the Department and National levels.*

In the field of management, he has coordinated agricultural programs among departmental governments in Colombia. At the Inter-American Institute of Agricultural Sciences he has filled the following positions: Technical Advisor to the Regional Office for the Andean Zone (Bolivia, Colombia, Ecuador, Peru and Venezuela) from 1968 to 1974; Interim Director for the same zone in 1975; and current Director of the Simon Bolivar Fund, headquartered at the Central Office in San Jose, Costa Rica.

More than thirty technical publications provide proof of his important contributions to his field of expertise. This book is an additional example and will be very valuable for those in our continent who have assumed the heavy responsibility of bringing progress to the rural setting.

José Emilio G. Araujo
Director General
IICA

FOREWORD

TO THE EDITION IN ENGLISH

The countries of the English-speaking Caribbean are in the main small in size, with a very limited natural resource base which can be utilized for economic development. They share an historical background which, together with similarities in their resource base, has led to many similar developmental problems.

As dependent colonial territories they were important producers of primary products such as sugar, coffee, cocoa and bananas for the markets of metropolitan countries.

As a result, their agriculture has been dominated by the plantation system under which those crops were produced on large estates, and the production of food for local consumption received limited attention. This system of agriculture has collapsed, and measures to create a system of commercial agriculture, based upon the many small and few medium-sized farms which have largely replaced the old system, have been both inadequate and ineffective.

At the present time, agriculture with a potential for providing a more significant proportion of the food needs of the area and for offering employment to the rapidly increasing population is widely recognized as one of the important bases for economic and social development. Additionally, in many states where tourism development and/or potential is considerable, the important linkages which can be created between tourism and the domestic sector, through agriculture, have also been appreciated.

But everywhere in the area, the agricultural sector is in urgent need of modernization and the development of commercial agricultural production. There is a need not only for efficient organization and operation of problem-solving research, but also of an effective delivery system for such important services as extension, credit, provision of agricultural inputs and agricultural marketing. A satisfactory method for organizing the numerous small farms which dominate the sector is equally critical to the achievement of such an objective.

The purpose of the Inter-American Institute for Cooperation on Agriculture (IICA) is to stimulate, promote and support the efforts of the Member States to bring about their own agricultural development and rural well-being.*

In recent years, the Institute has attached high priority to strengthening its technical cooperation in the Caribbean area by means of various forms of assistance. Guillermo Guerra's book has been reprinted three times in the original Spanish, and this translation into English marks the beginning of the Institute's contributions to the dissemination of English-language literature on Agricultural Economics, which is one of the most pressing needs of the area.

The present text deals with a wide range of topics in the field of farm management, including the planning and operation of commercial units and the organization of associate enterprises. It should prove valuable to administrators, extensionists and a range of professionals working in the agricultural sector.

(*) The new name of the Inter-American Institute of Agricultural Sciences.

José Emilio G. Araujo
Director General
Inter-American Institute for Cooperation on Agriculture

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Part of the material in this text is derived from a work published in November of 1963 under the title, "Farm Management in Land Reform and Economic Development" by Richard G. Wheeler and Guillermo Guerra E. in Vol. XXII, No. 59, of the Magazine of the National College of Agronomy of the Colombian National University.

To my wife Libia and our children.

PREFACE

The need for structural changes, although it permeates all sectors of the economy of Latin American countries, is the greatest in the rural areas.

Structural changes in this sector are related to institutional conditions, such as land tenure, credit, and the production and marketing of agricultural products.

Many of these changes are achieved either through local farmer initiative, through legislation for the benefit of farmers, or through their own organizations. Other changes are introduced by the government through modifications in the public sector which affect the economic, social and political environment of agricultural endeavor. As these two types of changes are interrelated, they necessitate the participation of a number of disciplines, including business management for agricultural enterprises.

Within this context, the role of agricultural management is to apply principles and laws from various sciences and disciplines, principally those related to management, economics, psychology, sociology, anthropology, and agricultural and livestock technology, to the resolution of managerial and socio-cultural problems of the agricultural enterprise.

Nevertheless, this book concentrates not only on individual businesses but also on the totality of farms in a country or region. Consequently, the analysis of agricultural business management which is presented herein describes two levels: that of the individual or associative enterprise in which farmers must improve their resource use; and the regional or national level, in which agricultural and livestock policies must be developed on broader terms. This includes the use of regional analysis methods.

This book has been designed primarily for use in farm management courses taught in agricultural science departments of Latin American universities. Nevertheless, it is also considered useful for specialists in rural development programs, agrarian reform, supervised credit, and agricultural extension. It presents to all these professional groups a precise and orderly analysis of the principles and methods of planning and analysis for agricultural enterprises.

The book is divided into two parts. The first consists of seven chapters in which the principles and methods of planning and analysis for the agricultural business are presented. The second consists of three chapters containing a practical guide for the reorganization and planning of agricultural businesses. Each chapter has its own bibliography so that the reader may delve more deeply into those subjects which may be of special interest.

Farm management is not only taught in the classroom, but is improved and better understood when applied to practical farm activities. In order to give the book a more practical focus, its possible uses were taken into account, and the autor included his experience in extension and development programs in various countries of Latin America, as well as research projects in agricultural economics, rural development and agrarian reform activities, classes, seminars, lectures and articles.

PART ONE

PRINCIPLES AND METHODS FOR THE ANALYSIS AND PLANNING OF THE AGRICULTURAL ENTERPRISE

INTRODUCTION

Modern planning techniques for agricultural enterprises vary from simple partial budgeting to linear programming. This book will concentrate on methods of analysis and planning of agricultural enterprises, placing special emphasis on budgeting as a planning tool for farms.

The principal objective of this chapter is to discuss the meaning and scope of management in the agricultural enterprise, its goals and its relationship to other sciences or disciplines.

The study of how agricultural producers use resources (land, labor and capital), how they plan changes in their use of resources and how they can improve it belongs to the field of farm management. However, this field includes not only the process of agricultural management as applied to the individual business, but also the study of farmer groups which exist in any given country.

Farm management is not a specialized branch of pure science; its role is to apply the various sciences to achieve success for the business. It includes consideration and appreciation of the economic consequences of alternative plans of action (including inaction) to be used as a decision-making guide for individual producers and for national-level planning and management of agricultural policy.

The objectives of farm management are:

– Helping individual producers to make better use of resources in a manner which is compatible with society's well-being.

– Providing a fundamental analysis of the efficiency of national-level combinations of resources to serve as a basis for improving public management of resources in planning agricultural policies or determining the orientation of institutions which control production efficiency.

Various interrelated sciences, disciplines and fields of study apply to farm management, some pertaining to the natural sciences and others to the social sciences. Although it is not necessary to make a comprehensive list of them, a few examples include management, economics, sociology, anthropology, psychology, political science and the natural sciences.

Farm management involves the application of agricultural and livestock technology and a mastery of techniques for practical organization based on systematic and scientific studies of the production of goods and services.

Farm management is a discipline and an art whose objective is to integrate and apply a set of sciences, fields of study and agricultural technology to the solution of managerial, social and cultural problems and the physical and economic efficiency of production within the agricultural enterprise.

The natural sciences, in combination with other sciences, generate technology and help apply it in efforts to increase production levels and introduce crops and animals adapted to the surroundings in which the business operates. In their work to apply modern technology, they also give the farmer the means to accept new changes.

The social sciences are used to incorporate the human factor into the production process through broad participation.

Managerial sciences facilitate the decision-making needed for coping with the multiple problems of management which arise in the business. Many of these decisions are of an economic, technical or socio-cultural nature. Some must be based on simultaneous consideration of multiple factors.

Economics provides a basis for organizing the economic production of the enterprise in order to provide sufficient income to cover the costs of land, labor, capital and management, leaving sufficient margin for debt payment and for covering the expenses of the farm family, and to reserve funds for savings.

In the area of economic considerations (application of production economies), four important decisions must be made (Hedges[13]). The first is related to problems of converting company resources into final products, that is, the factor-product ratio. For example, this would include the quantity of fertilizers, labor and other elements which must be combined with land to obtain a given product. The second relationship seeks the most effective method for combining two or more factors to obtain a given product, that is, the factor-factor ratio. For example, it is necessary to determine the best combination of forage and feed concentrate to maximize milk production. The third relationship specifies what should be produced, how much of each crop should be planted, and the most efficient use of the available resources. This is called the product-product ratio, since it is necessary to choose various products. The fourth decision involves the amount of time between the point of making an investment in land, building and machinery, and the moment the investment begins to generate income through the productive process. This is called the "time decision" and requires the producer to calculate the value of expected future income.

Besides the process of decision-making which, as noted earlier, has economic, administrative, technological and social implications, farm management involves:

– managerial procedures which, in the case of community enterprises, should guarantee member farmers full participation in the decision-making process;

– organizing the enterprise by combining the farmer's work with the most appropriate tools and thus achieving maximum efficiency in the systematic and coordinated use of available labor;

– acquiring capital for the business, including both individual and share capital;

– planning agricultural production including exploitation systems (comunal, mixed or individual);

– keeping in mind the relationship between the enterprise and national and regional planning efforts. This involves development plans and government policy in the agricultural field;

– maintaining the proper relationship between the enterprise and regional planning and production programs;

– managing (controlling and guiding) the various activities of the enterprise;

– coordinating (synchronizing and unifying) internal and external activities;

– establishing communication; that is, transmitting information, orders, etc. within and outside of the enterprise;

– maintaining control; that, is verifying the results of activities according to pre-established plans and instructions;

– applying technology to the agricultural production process;

– observing the internal and external social relationships of the enterprise;

– training farmer groups in the technical, administrative and social processes related to the business.

The following chapters give a more in-depth analysis of each of these aspects within the context of agricultural management.

CHAPTER 1

CHARACTERISTICS OF AGRICULTURE

The total agricultural production of a country comprises the sum of production of all the agricultural enterprises, farms, and production units. Agricultural progress depends largely on good management of each farm, no matter how small its size or volume of business or how simple its organization.

The management of the agricultural enterprise is carried out within the agricultural sector. Agriculture has special characteristics that distinguish it sharply from the industrial sector and define the special relationship that exists between the two. A review of the factors which characterize agriculture will assist in understanding the differences and relationships between agriculture and industry. It will also serve to explain why farming requires special treatment in the agricultural policies of a country.

Frequently, farmers are advised to adopt systems of operation and organization developed in other industries so as to eliminate most or all of their management problems. Nevertheless, agriculture is different from other industries in so many basic ways that managerial techniques used in other fields, such as the steel industry, the automotive industry, wholesale distribution, or retail merchandising, have little or no application to agriculture. This can be observed by the frequency with which successful entrepreneurs from other fields suffer severe losses when they move into agricultural production. For these reasons, the principles of farm management cannot be based solely on the managerial methods used in other areas, such as industry.

The elements which characterize agriculture and differentiate it from the majority of other industries can be divided into the following groups: basic factors of production; organization; financing; and continual change.

BASIC FACTORS OF PRODUCTION

The basic factor of production in agriculture is biological, while in the majority of other industries it is mechanical. The farmer works with living materials. Diseases and pests may appear very unexpectedly, and small changes in weather can have a severe impact on production. For example, if a hog suddenly develops cholera symptoms, even the immediate implementation of a vaccination and quarantine program cannot prevent serious losses.

The manufacturing industry, by contrast, is not subject to such rapid and severe changes. In this industry, sudden losses can occur, such as a breakdown in machinery or a stalled delivery truck. In these cases, losses are in terms of time and actual production and, if the damage is repaired quickly, the capital and income structure of the business is not threatened, as in the case of agriculture.

Because of its biological character, agriculture is a high-risk industry. In the agricultural enterprise, any variation in weather, temperature, precipitation or humidity requires a readjustment of the day's or perhaps the week's work. The majority of the other industries are less affected by such variations; although they do run risks, the danger is less. This is why almost all non-agricultural, industrial operations have insurance to protect the producer against loss. This type of coverage is not easily available to farmers; and management practices must therefore be duly modified.

These contrasts are not meant to belittle the problems of other industries, but to show the differences among various types of management.

ORGANIZATION

The majority of industrial enterprises are organized on a large scale. This allows for standardization of production, increases in the volume of products marketed, national and international advertising campaigns, and production control to sustain constant levels or adjust to general price shifts.

Because of its intrinsic nature, agriculture does not easily adapt to large-scale operations.

A great deal of the economic theory on perfect competition is much more realistic for agriculture than for industry, and research has indicated that prices of selected agricultural products tend to be very similar to prices likely to occur under conditions of perfect competition.

Aside from these size factors of the production unit, other important characteristics involving the organization of the sector also deserve special mention. These include standard production; the constant need for quick decisions; and the reaction of agricultural production to price fluctuations.

Standard production

Many non-agricultural industries produce great volumes of highly standardized items. With the use of machinery and well-trained personnel, it is possible to make a large quantity of articles exactly identical in size, shape and quality. Such practices are impossible in agriculture. For example, after more than 60 years of scientific potato research and the selective breeding of the most desirable types, we still have no two identical potatoes. Seed which is planted one year will give a very different product the ensuing year, in terms of size and uniformity. Although farmers have developed many systems of classification and standardization, they have still not been able to market absolutely uniform products.

The process of classification is costly and thus can only be done in large volumes to reduce costs. This usually cannot be accomplished by the individual farmer, but must be handled instead through associative businesses, cooperatives or similar organizations. In many countries, only the relatively uniform products are sent to market. By means of special programs, such as sizing services, cooperatives, etc., nationwide or statewide classification and sizing regulations have been introduced for certain agricultural products.

The management problems of the individual farmers are different from those of industry, due in part to the fact that their products represent only a small percentage of the total market supply.

The constant need for quick decisions

The characteristics mentioned above lead to another organizational difference between agriculture and industry: the constant need for quick decisions. All types of agricultural endeavor require the farmer and all the employees to make fast decisions. Farmers must be skillful at adjusting to changes in the work environment.

When a flood occurs or a storm damages the crops, the fields must be drained and damaged plants removed immediately. There is no time to call board meetings, prepare summaries or discuss at length the relative merits of drainage or the potential losses incurred from additional labor and other costs; decisions and action must be taken quickly.

Price fluctuations

Generally, industrial enterprises are organized under some form of monopolistic control or other type of structure to isolate them, to a greater or lesser degree, from the framework of perfect competition. Agriculture, on the other hand, comes closer to possessing the characteristics of perfect competition. When prices of industrial products vary, the industry can adjust its production more or less rapidly to a new level because it is not subject to climatic or biological conditions of production. If prices rise, the industrial production process can be stepped up to produce a greater volume, and therefore, yearly production and prices of the majority of industrial products move in the same direction. When prices fall, production decreases; when prices rise, production tends to increase.

In agriculture, prices and production generally move in opposite directions. A relatively large volume of production tends to depress prices; a small volume tends to boost prices. In the short run, the difference is caused by the fact that the farmer has little or no control over volume of production due to the characteristics of agriculture analized above. In industry, this can be avoided by varying production schedules. Even in the long run, there is some doubt about the ability of agriculture in general to adjust production and satisfy certain price conditions.

In summary, prices and profits in agriculture fluctuate to a much greater degree than those of other industries, owing principally to the inability of supply to adjust to demand in the short run.

Also, seasonal variations dictate specific harvest periods, thus preventing supply from adjusting rapidly to demand. Supply is seasonal, while demand is constant. This situation also affects prices and marketing practices by creating a need for intermediaries to buy, store, transport and transform products to be delivered to the consumer at the moment they are needed.

Finally, the perishable nature of the majority of these products places the farmer in a difficult situation, reducing his "contracting power" and limiting his influence on supply and on product prices.

FINANCING

In the area of financing, the problems of the agricultural sector are also different from those of other businesses. Since agriculture is subject to many adverse risk factors, it is both difficult and costly to obtain investment and insurance against risks in agricultural production. In addition, the time necessary for recovering the capital investment is slow, and interest and forms of payment differ from those of other types of investments. This means that special credit and farm management practices must be adopted, different from those of other industries.

The basic measure of efficiency in the use of capital for business in general is the time needed for capital recovery, that is, how fast the original capital is recovered through commercial receipts. A rapid rate of recovery indicates efficient use of capital. In retail businesses, such as pharmacies, supermarket chains, department stores, and others, the time required for capital recovery is normally from one to three months, that is, total commercial receipts after one to three months are equal to capital invested. In agriculture, this period varies from seven to nine years for beef cattle and from one to three years on dairy farms. Diversified agricultural firms including both crops and livestock have a recovery time of approximately five years. Most non-agricultural businesses have recovery periods 10 to 20 times faster than those of this sector.

Capital recovery in agriculture is relatively slow because the production process generally requires variable time periods. This does not mean that agriculture is inefficient; but it does mean that farmers must face management problems related to use of capital considerably different from those of other industries, which in turn implies that new credit solutions must be found for credit and financing problems in agriculture.

CONTINUAL CHANGES

The process of agricultural production is in constant flux. The changes affecting this industry can be classified into four groups: economic, physical, technological and institutional.

Economic changes

The prices which the farmer receives and pays change continuously according to the supply and demand of products and inputs. Such price fluctuations require farmers to readjust production decisions in view of new situations.

Physical changes

These are outside the control of the farmer and include variations in climate, such as droughts and floods, as well as pests and diseases.

Technological changes

Every day, new plant varieties are developed which have shorter growing seasons and are more resistant to pests and diseases. Likewise, new machinery and equipment are introduced for improving product quality.

Institutional changes

Changes in government produce changes in policy orientation in general and in the agricultural and livestock sector in particular, as well as modifications in institutional structures. This means that management and organization in the agricultural sector undergo changes which affect the type and quality of services (credit, extension, promotion, marketing) available to farmer; and influence land tenure systems and the number and size of farms in the country.

RESOURCES AND FACTORS CIRCUMSCRIBING THE ACTIVITIES OF AN AGRICULTURAL ENTERPRISE

Before describing the different types of existing enterprises, it is necessary to analyze the types of resources used by the enterprise to reach its fundamental goal, that is, the transformation of resources, or inputs, into products. It is also appropriate to analyze those internal and external factors which condition production and productivity (Brevis and Jolly[6]; Segundo Curso Nacional de Administración Rural[24]). See Table 1.1.

Production resources

These resources have two characteristics: they are scarce and they have alternative uses. Their contribution to the production process varies, but they never act in isolation to obtain a given quantity of production. The quality and quantity of the resource, the techniques employed, and the skill used in obtaining the best possible combination all help to determine the quality and quantity of the final product. Although the combination and interrelationships of resources vary according to different agricultural zones, for teaching purposes these resources are classified into three groups; natural, human and capital (Segundo Curso Nacional de Administración Rural[24]).

Natural Resources

These resources are provided by nature and thus have a strong influence on product selection (Brevis and Jolly[6]). There are three types of natural resources: land, water and climate.

Land. This category includes air, sunlight and soil composition. Thus the suitability of land for agricultural purposes varies according to its nature, topography, fertility, permeability, depth and degree of erosion. These variations in turn make it possible to use the land for different crops. Shifts in fertility, slope, depth, permeability or erosion determine agricultural applications, and all these variations affect yields and determine soil management and conservation regimes.

Some authors classify land as capital because it is a scarce resource whose commercial value depends on human effort, quality, and accessibility to markets. Moreover, land title is a form of savings and investment, for land owners expect a return on their investment greater than or equal to what their savings would have produced if they had been invested in some other type of real estate or activity.

TABLE No. 1.1. Resources and factors circumscribing the agricultural enterprise

RESOURCES	Natural	Land	
		Climate	
		Water	
	Human	Farmer	
		Unpaid Family	
		Contracted	
	Capital	Investment	
		Fixed operating	
		Circulating operating	
	Managerial		
FACTORS	External	Land reform	Tools which form part of agricultural policy
		Prices	
		Markets	
		Transportation, Roads	
		Legislation	
		Credit	
		Technical Assistance	
		Community Development	
		Research, Technology	
	Internal	Size or volume of business	Tools controlled by the farmer
		Crop yields	
		Livestock yields	
		Selection and combination of products	
		Labor efficiency	
		Machinery and equipment efficiency	
		Marketing methods	
		Personal circumstances of farmer and family	

Water. The availability of this resource is another factor that helps determine what can be produced; thus it is necessary to know both the specific water requirement of various crops and the availability of water during the seasons of the agricultural year.

Climate. Each crop also has a very specific season for planting and harvesting, defined by water and temperature requirements for the normal development of plants and animals. Consequently, it is important to maintain records of the quantity and distribution of rainfall to be used as climate indicators.

Human resources

The traditional source of human labor on family-run agricultural enterprises is the farm family itself. Other important types of human resources are hacienda laborers, plantation workers, agricultural specialists, agronomists, veterinarians, and zoologists. The agrarian reform process in some Latin American countries is giving rise to new types of agricultural enterprises in which work is provided by the campesino members. Campesinos are defined as "persons of limited resources who derive their livelihood from the rural sector."*

Consequently, the campesino has the double responsibility of both providing hand labor, through work and managerial skills, and making decisions on such matters as the nature, methods, and quantity of production, and selecting the system of exploitation (communal, mixed or individual) to be employed. This area of decision-making also extends to the internal organization of activities, input and food supplies, and product marketing. Consequently, campesinos must be trained in this area so as to handle effectively the new responsibilities imposed by the application of agrarian reform programs.

Additionally, the various participants must be provided with adequate wages and with the housing, nutritional, health, and educational services they need to attain standards of living at least comparable to those of other productive sectors.

Capital resources

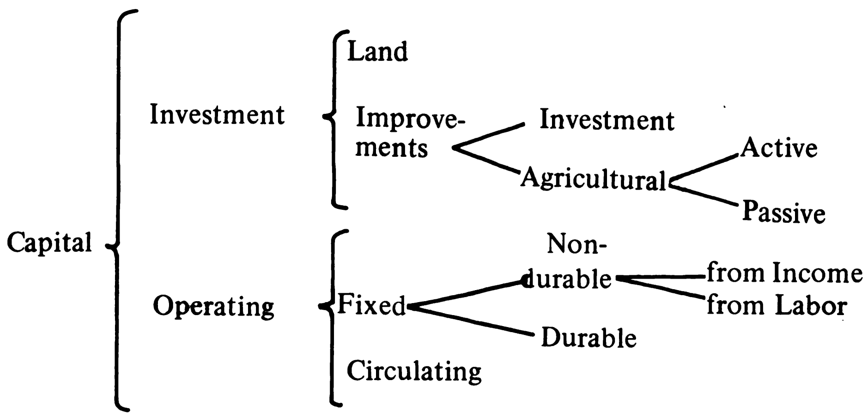
Capital is defined as the whole set of goods produced by human activities, and available for use in the production process. Capital in the agricultural enterprise consists of machinery, equipment, buildings, improvements, livestock, and supplies.

Table 1.2 gives the classification of capital resources developed for the Course on Farm Management given in Pelotas[24] and adapted by the author. The categories are defined as follows:

(*) Definition suggested by the Fourth Inter-American Meeting of Agrarian Reform Officials, Panama, May 15-20, 1972.

Investment capital. This includes land and improvements. Improvements from direct investment are incorporated into the land and cannot be appraised separately from it. They include drainage, irrigation facilities, leveling, and removing tree stumps.

TABLE No. 1.2. Classification of capital resources



Agricultural improvements are investments of a permanent nature which are incorporated into the land and can be valued separately, but not withdrawn physically without causing damage. They can be active or passive. Active improvements have a vegetative life and are productive goods tied to the land for more than one agricultural season, such as permanent fruit, forestry or forage plantings. Passive agricultural improvements include real estate holdings which do not produce by themselves but do contribute to production, such as buildings and installations.

Operating capital. This category comprises fixed operating capital and circulating operating capital.

Fixed operating capital includes goods for production, either alone or in combination with other inputs, that last for more than one agricultural season. They can be durable (machinery, tools, implements) or non-durable (animals, both income-producing and labor-producing).

Circulating capital has a life of not more than one agricultural season, has no fixed identity, and causes cash flow movements. It includes wages, seed, fertilizers, pesticides, feed stock, transportation, taxes and gasoline.

Circulating capital should not be confused with direct expenses. (There are two kinds of expenditures: direct and indirect or capital.) Direct expenses are personal capital belonging to the farmer, but temporarily present in the productive process. The time period during which these funds are being used is the determining factor, and therefore only a part of direct expenditures constitutes circulating capital. The size of this proportion depends on: a) the time between the moment money is needed for a direct expenditure and the moment the money is recovered in the form of income from the sale of a product, and b) the frequency of turnover of the cycle of income generated during the agricultural season.

The direct expenditures are equal to circulating capital only when the expenditure is made at the beginning of the agricultural year and the money is not recovered through product sales until the end of the year.

Management

This subject will be studied in the following chapter.

External factors

In the process of decision-making, the campesinos must juggle a series of factors over which they have no control, including agrarian reform, prices, markets, roads and transportation, legislation, credit, technical assistance, farmer organization, community development, and research and technology, all of which is provided by various governmental agencies, according to agrarian policy positions.

Internal factors

These factors are under the total or partial control of the enterprise and therefore are called internal. They include size and volume of the enterprise, crop and animal yields, product combinations, labor efficiency, machinery and equipment efficiency, marketing methods and the personal circumstances of the producers and their families

TYPES OF AGRICULTURAL ENTERPRISES

Various methods exist for classifying agricultural enterprises. The definitions in this book are the product of historical-political-social processes and are closely tied to the agrarian structure which predominates in each country. They may appear to be imprecise or to omit some of the components which actually exist. Nevertheless, they are considered appropriate for the purposes of this book, as they have been promoted and disseminated with slight modifications in several countries through existing legislation.

PRIVATE ENTERPRISES OF AN INDIVIDUAL OR CORPORATE NATURE

The first category includes the classical **latifundio** and **minifundio** systems, operating on an individual or corporate basis. Also, the traditional family enterprise, which continues to exist as a response to defective agrarian structures in some countries, belongs to this group.

Latifundio

Although often viewed as an enterprise based on economic considerations, according to Garcia[9], "the **latifundio** constitutes a multifaceted system of social domination based on a monopoly of the land. Historically, the social picture in Latin America is characterized by a diverse range of types of **latifundio** structures and by a diversity of integrated and original systems that make up the composite whole."

The **latifundio**, according to Garcia, is characterized by: "an inaccesible system of ownership structured, historically, for social domination; this system has not been modified by the capitalist mechanism of a land market (purchase, sale and rental), and the process of expanding the number of landowners has taken place at the level of small family units and **minifundios** as a result of the pressure of inheritance and the strong campesino desire for land.

"It is a system of work with no promotion, based on immersion,* paternalistic relationships and the obstruction of communication at a national level. . .

"It is an entrepreneurial system devoid of rational standards for expenditures, investment, or productivity. . .

"It is a system of national relationships dependent on the rural power structure: this is why the **latifundio** exercises such predominant influence in relation to the national system of marketing, culture and political organization."

(*) "Immersion is defined as a state of incommunication or isolation of the rural masses imprisoned in the social composite of the *latifundio* and cut off from the processes of change, of political power, and of participation in the activities that typify, strengthen, and vitalize the society of a country."

The **hacienda** is a typical **latifundio** enterprise in Latin America. It is characterized by its large land holdings, low investment of capital, and cheap labor. It also attempts to meet all its own consumption needs through internal production. Its owner is not concerned with the productivity of the land, but only with the profitability of the operation (Suárez de Castro[26]). That is, he is not interested in yield per unit of land surface or per head of cattle, but with total income based on low wages and access to the means of production which provide him with his ties to power. This is the case of the **hacienda** in Argentina, Uruguay and southern Brazil.

The plantation is another form of **latifundio** which appeared after the **hacienda**. It also has special characteristics which distinguish it from the **hacienda** in many respects. It has a large expanse of land dedicated to one crop (almost always an export crop such as bananas, coffee, cacao, sugar cane) and has a high level of investment capital. It is generally owned by a company or corporation and maintains an impersonal relationship with the worker. Labor is mechanical and unskilled, carried out by rural proletarians whose access to the administration never goes beyond their contact with the foreman, a person whose own position on the hierarchical scale of the enterprise is very low-level (Suárez de Castro[26]).

According to Tannenbaum, as quoted by Suárez de Castro[26], "the **hacienda** is not simply an individually owned agricultural holding. It is a company under private ownership and control. The **hacienda** is a social system that guides the life of its members from the cradle to the grave and considerably influences the rest of the country. The **hacienda** is economics, politics, education, social structure and industrial development." The **hacienda** has exercised, and in places continues to exercise, an isolating and conservative influence. It has maintained the time-worn, routine methods of sharecropping and thus impeded the incorporation of technological innovations into crop production; it has inhibited social mobility, discouraged trade and perpetuated a tradition of authoritarian relationships which lead directly to paternalism. It has restricted the accumulation of capital, for it resists change and thus has no need of new investment. Likewise, it has encouraged soil erosion (Suárez de Castro[26]).

Minifundio

Closely related to the **latifundio** is the **minifundio** which is defined as "that production unit in which the available land is absolutely insufficient to achieve the following three essential objectives: productive employment of the family labor potential, a supply of resources sufficient to maintain life, and the possibility of establishing a truly functional agricultural enterprise." (García[10]).

Some authors point out that, although the potential for labor may be insufficient, it can be productive. Others note that the **minifundio** does maintain life, but at a level of total poverty, and therefore is not desirable. The essential concept of the **minifundio** is its capacity to provide work opportunities for family labor and to yield income through which the farmer can aspire to an improved standard of living.

Family-run agricultural enterprises

Agrarian laws in a number of countries (including Colombia, Venezuela and Costa Rica) include the development of family-run agricultural enterprises as one solution (among others) to the problems of the **latifundio.** Traditionally, the family enterprise is viewed as a land area which provides work to the farm family and for occasional temporary laborers. It is assumed that the farmer possesses the level of technology necessary to support the family, cover operating expenses, and accumulate a certain margin of savings.

There are pros and cons to the concept of the family-run agricultural enterprise. They have been summarized by Araujo[1] as follows:

—The farmer acts as both administrator and worker, and the family members provide labor. This allows for more flexible planning of tasks, taking into account the needs and potential of the family.

—It gives the campesino an opportunity to exercise personal initiative and develop a business-like attitude.

—It guarantees a certain level of independence, security and prestige.

—Due to tradition and the predominant social structure in some countries, this type of farm is preferred by campesinos and has been well accepted by them, for its individualistic model is well-suited to their values and beliefs.
Restrictions on the success of the family-run agricultural enterprise include:

—It involves high fixed costs and often an inadequate level of investment due to the small scale of the business.

—It precludes the practice of large-scale planting and the adoption of higher levels of technology for animal and/or plant production.

—It limits opportunities for labor specialization. The campesino is both worker and manager and must therefore undertake a wide variety of activities.

—It promotes the isolation and individualism of distinct family groups, impeding the provision of social services such as education, public health, and recreation, and technical services such as extension and input supply.

—It forces the campesino to act alone in dealing with markets for products and inputs (means of production). This produces a price disadvantage in both sales and purchases. Additionally, the campesino receives inadequate market information as a result of isolation and the lack of communication and coordination in production activities.

—It encourages the tendency to subdivide land ownership among the descendents of the family, which leads to the **minifundio**. The family enterprise no longer figures as the only model solution to the problems of agrarian structure in countries such as Chile, Colombia, Peru and Panama, for the following reasons (Orchard and Ortiz[22]):

- This system makes it impossible to implement an agrarian reform program capable of affecting significant population groups and of breaking the power structure. In fact, evidence shows that the state of dependence of the campesino tends to increase.

- Even though land is turned over to the campesino, this does not constitute a real answer to campesino or national-level pressure on the agrarian structure.

- The realigning of territorial boundaries, one of the objectives of the new structure, is offset by the fragmentation of ownership.

- It prevents the rational use of land and other productive resources, including buildings and facilities.

- Due to the small size and volume of its operations, it is unable to reap the advantages of economies of scale.

- It tends to maintain the values of the traditional society.

ASSOCIATIVE ENTERPRISES

Other types of enterprises have been developed only recently and are in the process of formation. These have emerged during the last ten years as part of governmental efforts for a total reorganization of the structure of rural society, eliminating the problem of social, economic and political domination which is generated by **latifundio**, as well as the problems generated by **minifundio.**

A number of countries feel that the family-run agricultural enterprise does not solve these problems. Thus, they are creating new, diverse types of businesses based on associative patterns of tenure and use of land. For this reason they have been called campesino community enterprises (Orchard and Ortiz[21]).

Community enterprises

The brief explanation given above does not convey a complete idea of the concept. The more striking characteristics of communal firms will be discussed later, on the basis of the proposals and recommendations of the Fourth Inter-American Meeting of Agrarian Reform Officials[16].

For example, the definition of a community enterprise given by the Government of Colombia in Article 121 of Act number 4 dated March 29, 1973, states: "It is the associative form of production by which campesinos with scarce resources combine their labor, industry, services and other assets for the principal purpose of working one or more undeveloped pieces of land and industrializing and marketing their products, in order to divide among themselves, in proportion to their contributions, the profits or losses which may result. In community enterprises it is understood that agricultural labor will be undertaken by members. When required, community enterprises can contract the services necessary" (Orchard and Ortiz[21]).

Although the above definition contains almost all the characteristics of an agricultural enterprise, it can be criticized in several areas, especially when it states that the profits will be distributed among its members according to their monetary contributions rather than labor provided.

The characteristics of community enterprises are:

It consists of campesinos, which includes all members of the subjugated rural classes: Indians, wage-earners and the rural underemployed. This class-based definition differentiates it from organizations made up of agricultural producers who enjoy medium-and large-scale economic resources.

As a communal structure, it is based on common ownership and common use of the elements of the enterprise, on control of decision-making through active participation by the campesinos in company decisions, on the redistribution of profits according to work provided, and on turning excess profits back into the enterprise in the form of capital stock, thus not only benefitting the laborers, but also creating new productive activities (employment) and contributing to development of the whole campesino sector.

As a business enterprise, it seeks the most efficient combination of the factors of production and a rational use of natural resources in order to obtain economic returns.

According to Pinto[23], a business enterprise must possess the following essential factors:

—a given functional and administrative organization;

—a series of legal relationships defined by society, such as its corporate standing, its responsibilities toward other enterprises, its relationships with sponsoring institutions, and the set of standards and rules within which it operates; and

—an entrepreneurial process of reasoning, including the social and economic projection of existing resources enabling the enterprise to reach its established objectives and goals. This implies short, medium, and long-range planning.

This new concept of the farm as enterprise implies a new system of land tenure, production and distribution of profits. It has advantages from the economic standpoint, according to Orchard and Ortiz[21,22]: it makes available the benefits of economies of scale and facilitates income distribution, adoption of new techniques, implementation of national goals, rational use of resources, appropriate product marketing, creation of new sources of employment and reductions in the cost of government-provided social services.

From the sociopolitical point of view, it allows for organized campesino participation in the country's general development and in the national, regional and local planning process; it stimulates human equality and solidarity and community development; it facilitates a change of mental attitude in favor of development; acting as a pressure group, it accelerates the process of change; it makes possible a more effective integration of the poor campesinos into the development process by strengthening their political organization; it helps eliminate dependency relationships by developing the initiative for self-help programs; it facilitates training for all members in areas which enable them to participate actively in the planning and implementation of company projects and gives them the technical know-how they need to develop productive activities.

According to this explanation, campesino community enterprises must, by definition, satisfy the following conditions:

—Practice associative forms of production (self-managed or co-managed) in the field of agriculture, thus eliminating the need for other forms of cooperation related to agriculture, such as cooperatives for marketing, credit, consumption, and services. This is not meant to suggest that such associative forms cannot be either useful or appropriate in their own right.

—Maintain common ownership and communal control of resources and factors of production.

—Promote equality of rights, obligations and managerial and physical work in the enterprise.

—Require a personal commitment in the form of labor, either managerial or physical. This also implies family participation.

—Employ wage-earners when necessary.

—Distribute the profits generated by the firm in proportion to the work provided by the members.

—Enjoy certain ties with the government through an agrarian reform institute which may exercise partial, direct or indirect participation in the operation of the enterprise. This condition is generally of a temporary nature, since once the firm is established, it becomes private.

—Originate from processes of agrarian transformation. Examples of such community enterprises exist in Colombia, Chile, Panama, Venezuela and Peru.

—As noted above, there are differences in concept, operation, administration, and organization from one enterprise to another, according to Arana[2]. In Cuba, "these agricultural corporations are the highest form of cooperative. Here the individual farms have been consolidated and are worked collectively. Only under exceptional circumstances are wage-earners used. They work as a single production unit for obtaining credit, crops are sold collectively, and compensation for the members is determined according to the amount of work done. The group maintains a single set of books. . ."

—In general terms, the membership of the business consists of the campesino workers of the productive unit. Nevertheless, the definition is not iron-clad in this respect, since in some cases membership extends not only to the campesino heads of households, but also to relatives who live in the area or, in some cases, in neighboring communities.

Social Action Agricultural Corporations (SAIS): Peru*

This type of enterprise, created by the Peruvian government, is a form of associative business which could well serve as a model for other countries. The Social Action Agricultural Corporation of Peru, commonly called SAIS, is not very clearly defined in existing legislation, and its structure varies from case to case. "They are legally constituted, private, limited liability companies whose members are beneficiaries of agrarian reform laws. They are established whenever the General Office of Agrarian Reform and Rural Settlement deems it necessary. They are ruled by the basic principles of individual corporations and of the cooperative system."

In order to understand better the concept of an Agricultural Corporation of this type, it would be helpful to note several characteristics of the existing enterprises.

—At present some SAIS are basically a central unit made up of one or more **haciendas** (integrated into agrarian cooperatives for either production or service) expropriated through the process of agrarian reform, and individual campesino communities. In this case (that is, when the members are legal entities), the enterprise is created by a definitive court ruling and constitutes a second-degree group with an unlimited lifetime.

—When SAIS members are individual persons, the organization is considered a transitional step toward cooperatives. Its lifetime is variable.

—In other cases the SAIS combines numerous service cooperatives and acts as a planning and service management unit.

—In reference to the use of land and human resources, the SAIS exercises two important functions for the cooperatives of which it is composed: a) marketing products and supplying inputs for the agrarian service cooperatives, and stimulating a policy of land consolidation among its members; and b) giving preference in assigning direct labor to those members of the service cooperative who do not possess individual plots of land.

(*) This section follows the guidelines of the documents presented to the Fourth Inter-American Meeting of the Agrarian Reform Officials (16) and Orchard and Ortiz (21, 22).

—When the SAIS is set up, factors that must be taken into consideration include the interrelationships between the system of exploitation of the firm and its profitability, the labor requirements and the number of beneficiaries to be involved in the legal proceedings.

—The SAIS should become a self-managed form of campesino enterprise which offsets the socio-economic imbalances in its areas of influence, distributing the benefits of the collective firm in accordance with the development needs of the various groups of co-owners.

—The SAIS should disseminate modern agricultural technology, training the campesinos to attain high levels of production and productivity. To this end, a development office exists to carry out education and action programs to increase campesino participation in the administration and management of the SAIS. This task has been handled by specialists from the National System of Support for Social Mobility (SINAMOS), but it is expected that gradually this will become the full responsibility of the SAIS.

—Associative ownership also exists for land and other agrarian holdings that are indivisible in nature. However, this does not appear to include lands belonging to campesino communities. (The campesino communities are legal entities composed of a group of families with a traditional culture who have common ownership of the land, work collectively, and are under the authority of their elected officials, also of a traditional background).

—Since the communities have their own lands, under either communal or individual ownership, and they are worked by community members, all income derived from them remains in the power of the community.

—All members participate in decision-making and in the management of the firm through the institutional mechanisms established in the by-laws. This characteristic is not totally valid, as a SAIS formed by legal entities (cooperatives or communities) is run by an administrative council of representatives of each member group. Of course, it is assumed that these representatives are democratically elected.

—The enterprise is committed to the efficient use of all resources it has been legally granted.

—The SAIS derives its income both by working the expropriated **haciendas** which have been organized into production cooperatives, and by implementing projects created or promoted by the corporation.

Cooperatives

According to cooperative theory, production cooperatives are companies constituted according to the basic fundamentals of cooperatives, stipulating that the members are the producers. These basic fundamentals require equality (political, social, cultural and economic), freedom and unity. There are seven principles: free entry, democratic control, limited interest on capital, division of surplus in proportion to participation, cash sales, cooperative education and political and religious neutrality. The concepts of production may vary considerably.

—The members may work directly and collectively to produce a given product for sale.

—The members may be producers on their own plots and combine their products to be transformed communally.

Coöperative enterprises fulfill some requirements which permit them to be classified as community entities in the sense explained above. Nevertheless, not all cooperatives are community enterprises. It is worth noting that some countries (like Colombia) have special laws for community enterprises, while in others (like Peru) the cooperative has become an associative enterprise possessing all the characteristics of the community firm.

STATE ENTERPRISES

Taking into account the role of the campesino and the state in agricultural enterprises, two basic models of firms can be distinguished: state-run and semi-autonomous (combined state and private).

State enterprise

The state owns the land and the means of production. The campesino participates in decisions concerning the fulfillment of plans made by the state, which is the owner of the income generated by the business. The campesino receives wages according to the type of work performed. This arrangement provides job security. The state must supply all the services which are required for the operation of the firm and for the development of the community.

An example of a state farm in Latin America appeared in Cuba with the creation of the "People's Farms" in early 1961, combining the cooperatives developed on sugar cane **latifundios** and the direct-management farms. These People's Farms were state enterprises belonging to the nation, in which the agricultural laborers were provided with medical attention, housing, education and all public services, besides their wages. These farms proposed to solve the economic differences which existed among cooperatives by reinvesting the income in the farm itself or in the creation of similar farms (Menjívar[17]).

Semi-autonomous enterprises

These vary according to the role played by the state and the campesinos. There are several types, but they more closely resemble owner-operated companies rather than state enterprises, as the state plays a role of shared responsibility.

The state participates as a member in the management and in the distribution of surplus. It can retain ownership of certain resources, but control is exercised by the campesinos. It can redistribute or reinvest its share of the surplus in the area or in the enterprise itself, with the consent of the campesinos. In some instances the state is a privileged member.

In any case, the state is the authority, provides the basic services to the campesino community, and supervises and legislates national and regional policies.

SUMMARY

Farm management is a discipline and an art whose purpose is to integrate and apply the concepts of natural and social sciences such as agronomy, management, economics, sociology, psychology and agricultural technology to the solution of the problems of physical and economic efficiency on the enterprise and to the solution of its managerial and socio-cultural problems.

The characteristics of agriculture as presented in this chapter are:

Basic production factors. It is biological and depends on, or is subject to, the climate.

Organization. In general, agriculture is not a large-scale operation, while industry is. This presents some disadvantages in terms of the difficulty of standardizing production, flexibility, frequency and rapidity of decisions, and reactions to price fluctuations. Owing to the biological nature of production –perishable products, seasonal crops, cyclical variations– prices and profits in agriculture tend to fluctuate more drastically than those in industry. The production of agricultural products is seasonal, while demand is steady. This characteristic also influences prices.

Financing. Capital recovery in agriculture is relatively slow in comparison with retailing, manufacturing, and other types of business. This is due to the biological and climatic dependence of agriculture. Agriculture requires a period of gestation or vegetation. This implies that the problems of credit and financing must be adapted to these characteristics.

Continual changes. Agriculture is always subject to change. Essentially this is due to the frequent economic and physical shifts in technology and institutions.

The resources available to the farmer are: natural (land, water and climate); human (family labor and wage-earning campesino labor); and capital, which can be broken down into land and improvements (fixed assets) and operating capital.

There are various types of agricultural enterprises. Some stem from historical-political-social factors such as **latitundios** (haciendas and plantations), **minifundios** and family-run agricultural enterprises. Others are the result of agrarian reform processes in which the government seeks to alter the social structure by creating associative enterprises such as cooperatives, community enterprises and social action agricultural enterprises. In other cases the state takes the initiative and promotes state farms, although the degree of state participation varies from one case to another.

QUESTIONS

1. Discuss some of the differences between agriculture and industry which affect management practices in agricultural enterprises. Prepare a comparative table and graph.

2. Describe the types of enterprise which exist in your area. Examine and analyze their advantages and disadvantages from the point of view of their contribution to the solution of problems of the agrarian structure.

3. Describe a community enterprise and compare it to a family-run agricultural enterprise.

4. Briefly describe the field of agricultural management.

5. Prepare a table indicating the sciences employed in agricultural management.

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CHAPTER 2

MANAGERIAL SCIENCE IN AGRICULTURAL ENTERPRISES

Programs of agrarian reform in Latin America are creating new types of agricultural enterprises different from the traditional family operation. Generally, these new companies have a greater volume of business and land and, consequently, their organization is more complex than that of the family farm. For this reason the study of business management assumes particular importance, since modern conditions make it necessary to borrow the managerial principles and methods used in other industrial enterprises. Nevetheless, the main characteristics of agriculture must be taken into account in the application of these principles. This chapter explains administrative functions and describes their role in agricultural management.

THE FUNCTIONS OF ADMINISTRATION

The administrative sciences are the result of an evolutionary process initiated many years ago, through which administration has evolved and acquired its own identity.

Administration has been defined as a "social science comprising technical and practical principles whose application to human groups makes it possible to establish rational systems of cooperative activities for the achievement of common goals beyond the scope of individual efforts." (Jimenez[12]).

This definition implies that management is considered a social science and thus has a body of laws, standards and techniques to be applied to human situations.

Administration is closely related to other sciences such as economics, sociology, history, geography, law, psychology and political science.

The definition also implies that the science of management contains a body of principles with which to direct individuals organized into formal groups based on common goals.

Another of the many definitions was put forward by Newman[16], who says: "Administration is the guidance, leadership, and control of the efforts of a group of individuals toward some common goal."

This definition covers some of the basic functions the manager exercises, such as planning, organization, resource gathering, direction, coordination and control.

PLANNING

Planning could be defined as the process of selecting future actions likely to produce desired results. It is a methodology for decision-making. Since decisions involve choosing between two or more alternatives, it should be added that planning is a methodology for selecting alternatives.

All planning implies two spheres of action: establishing objectives and goals and adopting the means or instruments most likely to produce them. If planning is to be effective in the fulfillment of objectives, it must be operative rather than merely theoretical.

Planning is done in every agricultural enterprise, however large or small. As the size of the business grows, this activity tends to become more complex. This does not mean, however, that if the business is small (single-family), planning is not important. It is a function that cannot be omitted if the enterprise is to be successful.

The planning process in an agricultural enterprise must include an analysis of plans drawn up in previous years, so that past problems can be identified and future plans can be improved. Various methods have been used in planning for agricultural enterprises, including partial and overall budgeting and simplified and linear programming. A detailed description of the first two methods and some basic concepts of linear programming appear in Chapter 3.

ORGANIZATION

The concept of organization has been defined and handled in various ways by different authors. The word "organization" has been used to denote: the process of gathering and arranging diverse, mutually dependent parts into a whole; a unit made up of various mutually dependent components, each with a specific function; a group of individuals gathered together for a given purpose; and any company's management staff (Terry[24]).

This book will apply at least two of these concepts, as organization in the agricultural enterprise implies the process of various managerial units working together to carry out established plans and maintain relationships between executives and employees. That is to say, it is a structure within which the operative and administrative tasks are carried out through a division of labor.

The goal of organization is to allow an activity or group of activities to achieve the best possible economic and social results. Consequently, organization requires a broad knowledge of the techniques involved in each activity.

Organization places great importance on three elements (Desruisseaux[8]): the worker, especially in terms of physiological and psychological attitudes towards the work; the work itself, including both intellectual and physical tasks; and the work place, which in this case is the countryside, where agricultural activities are conducted.

Organization also involves simplifying physical tasks. This means making the best possible use of available resources in order to obtain the best results.

According to Desruisseaux[8], Taylor originated the idea of simplification of physical labor. His studies in the industrial sector led him to establish certain principles which could be applied to the agricultural enterprise, especially the associative type:

– specializing the functions of supervision and implementation, that is, requiring work from each individual according to his or her knowledge and abilities;

– separating preparatory activities from implementation, letting non-specialized workers take care of the latter. This eliminates time-wasting in task implementation and improves the use of labor;

– studying and determining special techniques for each operation phase by reviewing the principles and methods; and

– distributing the benefits of simplification of labor.

These principles have broad application in the associative enterprise. In addition, such areas as training and distribution of benefits are inherent in them.

PRINCIPLES ON WHICH THE ORGANIC STRUCTURE OF THE BUSINESS SHOULD BE BASED*

The structure of the organization must take into account certain basic principles considered fundamental for an appropriate hierarchical-functional relationship. These principles are:

* This section follows the guidelines established by Ricardo[22].

Unified command

Subordinates have only one boss and bosses know who their subordinates are. Each activity is properly defined and fits into the overall organizational scheme.

Extent of control

The extent and limits of control depend on the size and type of the business. There are three important factors to consider:

Limitations on the number of persons to be supervised. It has been scientifically shown that one boss can efficiently control from three to seven subordinates.

Distance limitations. This refers to the physical distance between the controller and the person being controlled. This is important in large agribusinesses where centralization and decentralization must be considered.

Time limitations. This has to do with the periods in which control should be exercised. Timing and continuity are important factors.

Homogeneity of tasks

This is related to the idea of unified command. In general it includes the following aspects:

- each laborer on the farm or agricultural enterprise should know what his or her activities are;

- the purpose of each task should be clearly understood;

- work should be divided into partial operations, easy to carry out;

- the requirements of each activity or group of activities should be defined, and responsibility for undertaking these activities should be assigned;

- workers should be assigned according to their abilities and the job requirements.

Delegation of authority and responsibility

This covers at least three fundamental conditions:

- Managers must have responsibility and authority if their work is to be developed rationally and efficiently. Authority is defined as the right to divide work among subordinates.
- Limits on the delegation of authority must be clearly defined.
- Authority and responsibility should be delegated from the upper levels of the hierarchy toward the lower levels.

Correct use of personnel

This principle stems from those described above. Horizontal unity joining the various hierarchical lines has the unfortunate effect of lessening the task of supervision and control while increasing the need for coordination. Therefore, managers must know how to use it effectively.

In conclusion, the efficiency of a good, functional, hierarchical organization depends on the ability of the management to develop effective models of lines of authority that make the best use of the various departments and horizontal bonds at different levels.

ORGANIC STRUCTURE OF AGRICULTURAL ENTERPRISES

The organizational phase should be clearly defined. Its purpose is to produce the best possible combination of techniques to improve the company structure. One such technique is the organizational chart, a diagram of the administrative structure of the enterprise.

In the majority of family-run agricultural enterprises, these diagrams are very simple. Research conducted in Mexico by Cazarin[4] found organizational charts similar to those identified by the author in Colombia and Perú. These cases are very simple, for the organizational chart shows only the owner and the laborers.

In the case of medium-sized businesses, the chart was found to be slightly different (see Figures 1 and 2), for it included the foreman or administrator. A more comprehensive diagram was found in a typical hacienda in Peru (see Figure 3).

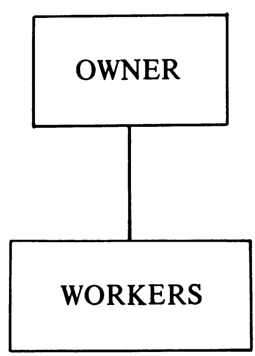

Fig. 1. Organizational chart for small family farms.

These traditional structures tend to expand with the introduction of owner-operated or communal enterprises established through agrarian reform programs (see Figure 4).

It is also possible to use a simpler structure, such as that discussed by Sampaio (Figure 5). In summary, each business should study its own structure and adapt it to its own needs.

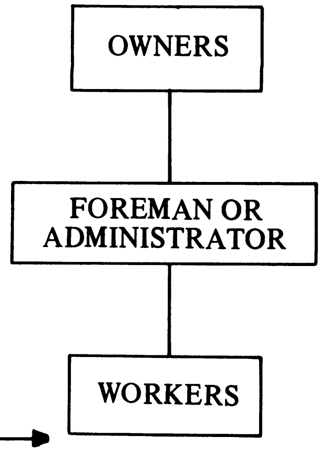

Fig. 2. Organizational chart for medium-sized farms

ASSEMBLING RESOURCES*

Another important function of the administrative process is the assembling of resources. This means not only acquiring all the resources (natural, labor and capital) necessary for the operation of the business, but also putting together external factors, often called intangibles.

The most important of these external factors is the legal structure, providing the framework within which the business must function. Second, it is necessary to consider the economic resources, or the relationship with the credit or financial institutions that provide investment and operating capital for the business. The third group is the institutional or social area. It involves relationships with the various institutions which in one form or another affect the operation of the business. This should include power groups, unions and campesino organizations, wholesale markets, agencies that provide transportation, technical assistance, etc. (see Table 1.1, Chapter 1). In other words, this means all those external factors providing essential support for the business.

The manager is responsible for assembling and handling these external factors so that they fulfill two objectives at the same time: 1) each agency providing external support must realize the advantages it will gain by cooperating with the business; and 2) feasible means must be developed for fulfilling the external objectives.

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* This section follows the guidelines set down by Newman[17].

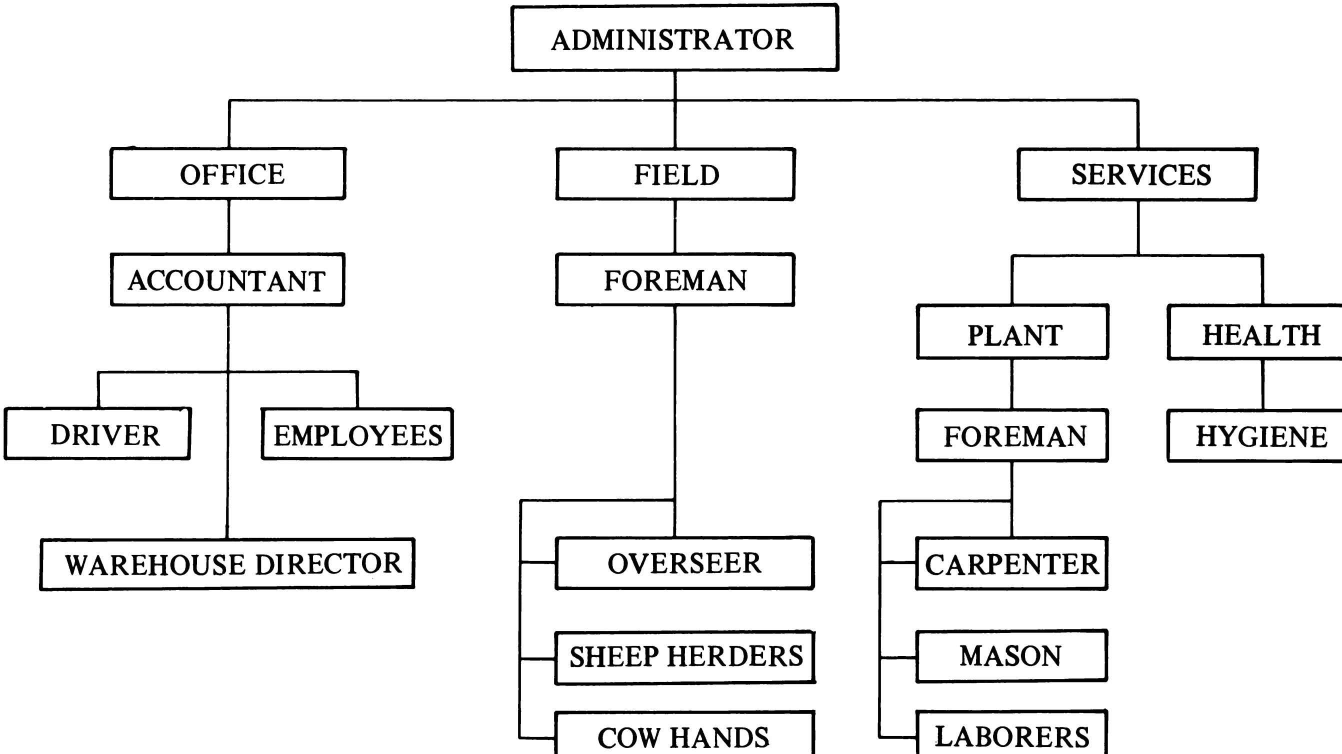

Fig. 3. Organizational chart of a cattle hacienda in Puno, Perú. (Source: PERU, MINISTERIO DE AGRICULTURA. **Organización de una hacienda ganadera en Puno**, Lima. Inf. No. 28. 1972).

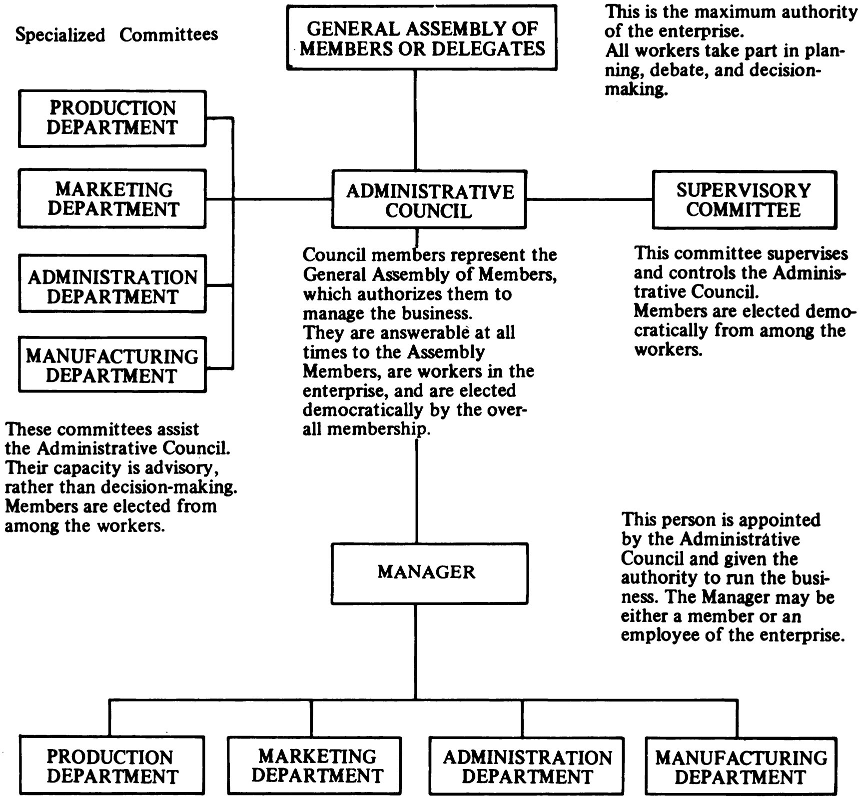

Fig. 4. Organizational structure of a self-managed enterprise. (Source: Centro Nacional de Capacitación e Investigación para la Reforma Agraria. **Organización de la empresa de autogestión en el sector rural.** C-4c (r-16) 70. 30 p. (Mimeograph).

DIRECTION

Direction has been defined as "the exercise of command, by providing subordinates with the guidance that can produce a flow of communication" (Ricardo[22]). It consists of the authority and practical knowledge needed to make the business run smoothly and the ability to solve problems as they appear and accept the responsibility for decisions. In short, it is guiding and conducting the day-to-day operations.

Direction means giving instructions, motivating the people in charge of carrying them out, and maintaining contact between executives and employees. The process of managing can be simplified with the use of both standardized methods and training (Newman[16]).

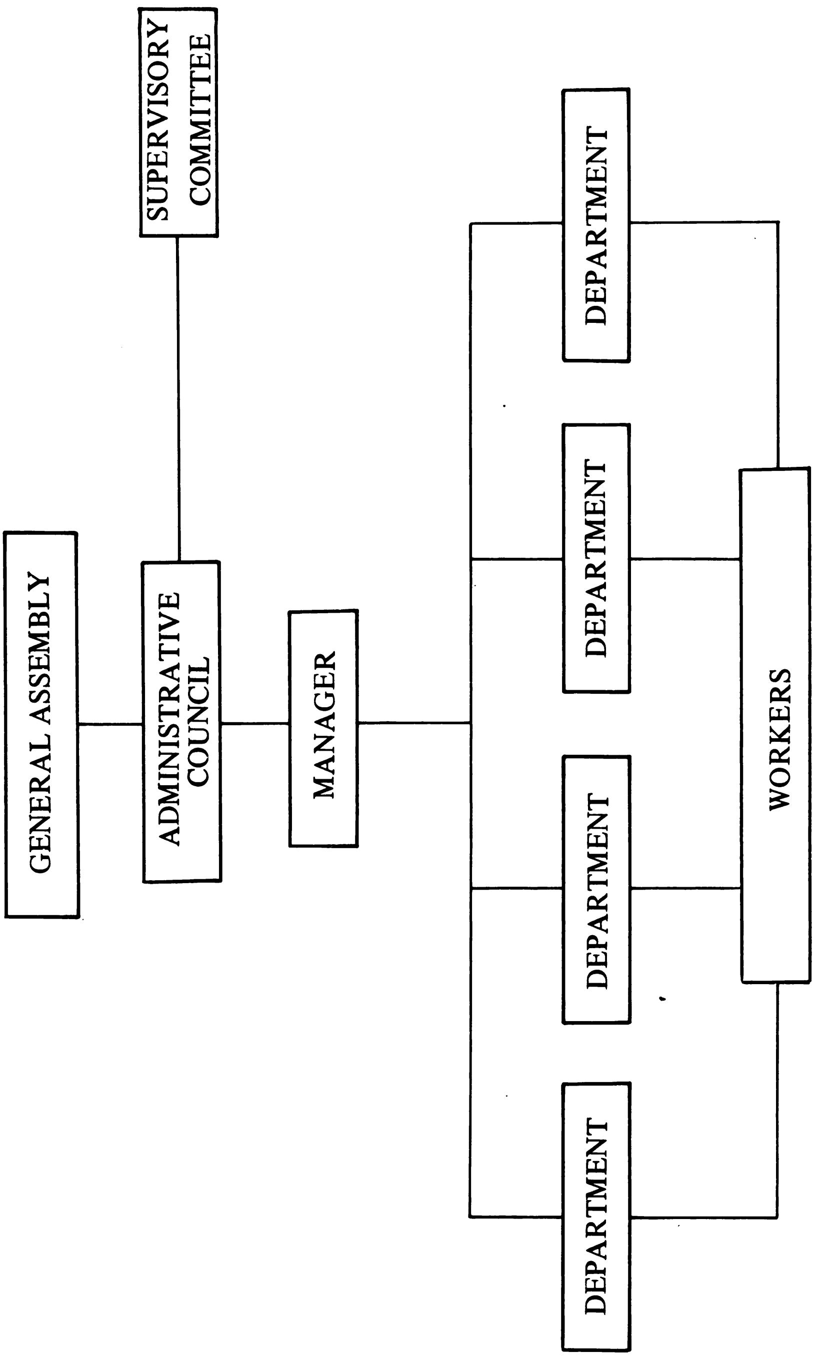

Fig. 5. Organizational chart of a community enterprise. (Source: Sampaio[23])

The idea of exclusive management has been eliminated from the new agricultural enterprises. No longer is the owner the lone decision maker and manager, for a decentralized board now must function according to the organizational structure of each business. The administrative council and specialized committees exist in order to enhance campesino participation in the decision-making process and the operation of the business.

The organization of management into departments or committees represents the delegation, rather than the diffusion, of responsibility. As a consequence, the administrative council or the most senior executive continues to exercise responsibility, must be answerable to superiors as well as subordinates, and must supervise and control the middle managers.

It can be stated that "administration is a technique for directing individual efforts within a formal framework, using scientific and moral principles as well as a broad understanding of the human personality, with all its potential and limitations" (Jiménez[12]). Thus, the human factor becomes the common denominator uniting the managerial functions.

Besides effecting the decision-making process described below, management acts as a motivator. It develops among employees the beliefs, values and attitudes that will help the individuals do their work in the best interest of the enterprise.

There are two other functions intimately related to management: coordination and communication.

COORDINATION AND COMMUNICATION

Coordination seeks to establish a system of contacts among those working on the implementation of a plan, so that individual efforts move toward a common objective.

The goal of coordination is to synchronize and unify group activities. It guarantees that all the constituent parts of the agricultural enterprise are harmonious and work together as a whole to achieve the proposed objectives. This is one of the two principal goals every executive tries to reach.

In order to achieve good coordination, the manager should consider the following aspects set down by Newman[16]:

– simplifying the organizational structure;

– harmonizing policies with programs;

– establishing a good system of communication;

– providing all the assistance necessary to promote voluntary coordination;

- coordinating the work by means of job descriptions, concrete instructions on activity coordination, etc.

Andrew and Willey[4] propose the following six principles for coordination:

- Preserving human values. Efficient coordination is needed to reduce tension and frustration to a minimum. This makes it possible to satisfy human needs such as feelings of safety and belonging. Achievements should be recognized and opportunities for developing creative ability should be made available. Thus the feeling of freedom of thought is maintained.

- Establishing communication channels to permit a free exchange of ideas. Since an organization is a combination of human relationships exercised through the delegation of authority and the establishment of responsibilities, communication channels must remain open.

- Keeping in mind basic interests and staff composition. This principle is fundamental both for organization and for efficient coordination.

- Orienting and supporting a democratic philosophy.

  Harmonious relationships among the members of an organization should be the result of a democratic philosophy which allows for the participation of all personnel, especially the campesinos, in policy planning and formulation and in sharing responsibilities.

- Facilitating plans for determining and evaluating staff efficiency.

- Establishing basic regulations for the work of the groups, making responsibility and authority for decision-making clearly understood.

Closely related to coordination is communication, defined as "the transmission of information or orders among the various elements and structural levels of the organization " (Ricardo[22]). Communication makes it possible to bring together all the parts and elements of the organization and stimulates people to work toward certain goals.

The functions of communication in an organization are:

- transmitting information and knowledge from person to person;

– motivating and directing people to action;

– molding and adapting attitudes and imparting beliefs to persuade, convince and influence human behavior;

– orienting people toward their physical and social surroundings.

In the case of associative enterprises, communication is an important factor, as it has been and continues to be necessary to promote new attitudes and values and to motivate workers in their transformation from wage-earners to owner-operators.

CONTROL

This consists of verifying that the results of the operations meet with plans and instructions. It is the interface between achievements and plans.

The central objective of control is to discover the errors or weak points of implementation and to correct them. For example, if a decision has been made to change the complete cropping plan for the farm, all details of implementation must be controlled to corroborate that the change really produces the expected benefits, and in the event that it does not, to make the necessary corrections. Control must include three stages (Desruisseaux[8]):

– **Observing a fact or given task,** such as total milk production over a given period.

– **Recording the information for subsequent consultation.** This record must allow for the nature of the activity under control, as well as the subsequent analysis.

– **Analyzing information.** This stage involves criticizing and analyzing the information by comparing it to specifically established models. The analysis should determine the measures necessary to correct the short-comings or errors.

Instruments or means of control

There are various methods of grouping and presenting business activities effectively for planning and control. The system chosen can be adapted to the specific crop or activity of the enterprise.

The bar chart or Gantt diagram is one method of representing the activities to be undertaken and the time needed to execute them.

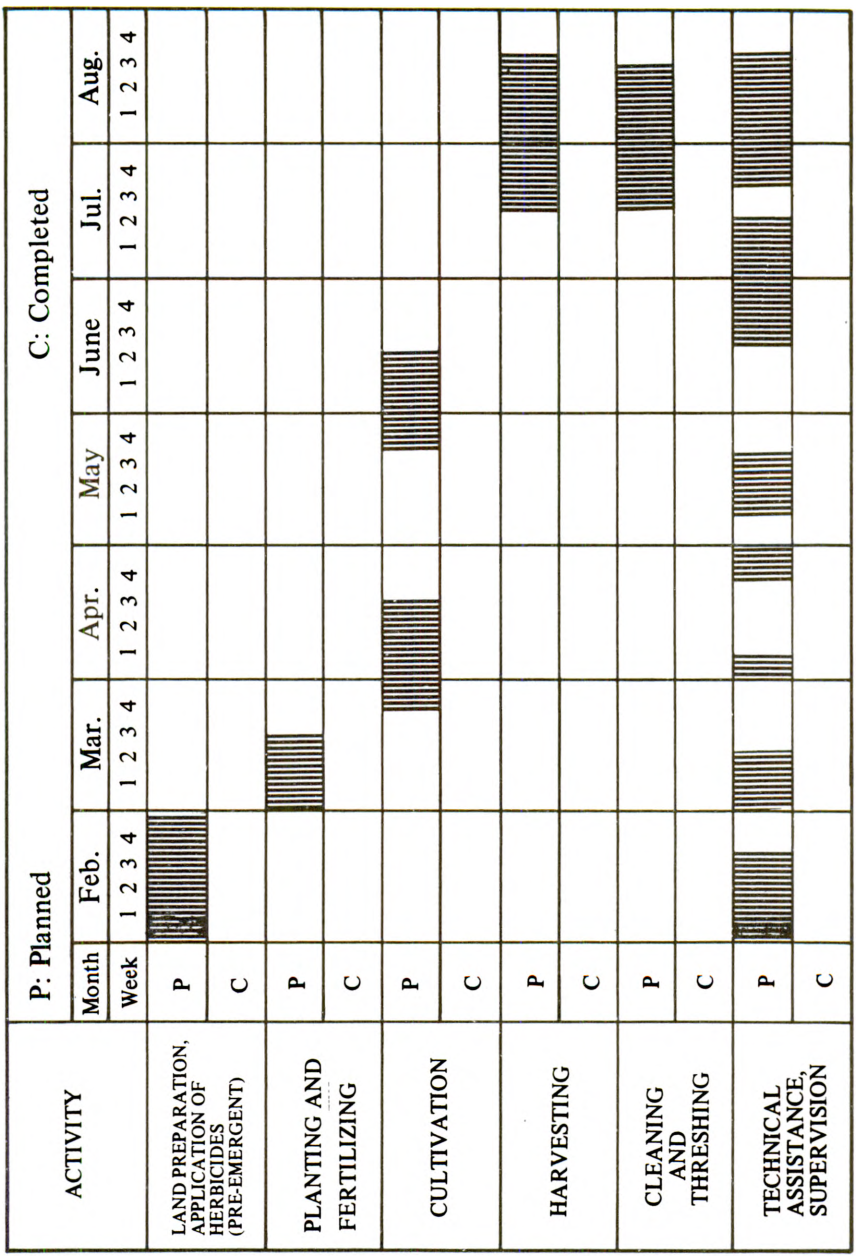

Fig. 6 **Planning (Gantt Diagram) for barley production.**

However, the disadvantage of the diagram is that it does not reflect the interdependence of the various activities (see Figure 6). A delay in planting due to heavy rains, for example, would change all other activities.

The PERT (Program Evaluation and Review Technique) is a technique for planning and control used in research and development programs. Given the complexity which production units are achieving, it has a broad field of application in community enterprises and self-managed businesses being established by agrarian reform programs.

Additionally, the PERT is a management tool for defining and integrating events or activities to be completed in a given time frame. It defines areas of work in which time, resources and events must interact if pre-established deadlines are to be met.

As a techique for planning and control, the PERT helps in the decision-making process; it is oriented toward the progress evaluation of projects underway; it focuses on potential or actual problems and gives frequent reports on the state of the project or business. In addition, it predicts the extent of objectives and determines the minimum time in which the project or activity can be implemented (PERT Orientation and Training Center[19]).

THE MANAGEMENT PROCESS

The management process is very similar for agricultural enterprises, factories, the home, and even personal matters. It has two principal phases: planning and execution. All policies, plans, programs, decisions and actions are closely tied to the management process, which can be broken down into seven consecutive stages:

- identifying the problems;
- gathering or observing data or factors;
- identifying alternatives;
- evaluating alternatives;
- selecting the best alternatives;
- taking appropriate action; and
- evaluating results.

The first four elements comprise the planning phase of the management process. The other three are the execution process. Planning is defined as the selection of future actions most appropriate for producing the desired results. In each case, information and judgment are the basis for action. Planning, decision-making, decision implementation and accepting the responsibility for decisions are the four principal obligations of the producer or operator. Wise decisions can be made only in the presence of principles, facts, imagination and analysis. When the action occurs, the process and its elements can be described as the decision process.

IDENTIFYING THE PROBLEM

The identification of the problem is generally considered the first stage of the management process. A problem arises for the manager or the administrative council when in a given situation it appears impossible to distinguish clearly between "what can be done" and "what should be done;" this leads the manager or the members of the council to establish an objective which represents the most satisfactory or ideal "commitment" or "action." However, in many cases the objectives cannot be selected until the final stage of the process is reached.

OBSERVING

Before proceeding, the manager may need more facts and observations. These new facts can help him or her identify the problem or seek out other information until the problems have been identified.

The manager should be careful and selective in choosing facts. In an enterprise in which low income is a problem, the manager should examine available resources, technical potential for using them, the market situation and characteristics, and the combination of resources most likely to help them be used effectively.

IDENTIFYING ALTERNATIVES

Facts, imagination and judgment can help the manager identify the most promising alternatives for future action; helpful ideas can often be found by studying accounting data of successful enterprises with similar resources.

One generally useful alternative is to make few large-scale changes. This is then used as a base plan and is compared with other alternatives involving some combination of interrelated changes. A milk producer, for example, may consider the alternative of buying more land, constructing new milking sheds, employing more labor or increasing the size of the herd.

These plans, however, are somewhat vague and incomplete. A more comprehensive description should include changes in machinery, land and buildings, cropping practices, and labor distribution. It is important to identify and quantify the various alternatives clearly and precisely.

Scientists frequently work to develop hypotheses which later may be accepted or rejected. The identification of alternatives in the management process can be compared to the development of hypotheses for the application of the scientific method.

EVALUATING ALTERNATIVES

When two or more alternatives have been identified precisely and quantitatively, the next stage consists of evaluating their effectiveness for producing the expected results. Scientists generally have a laboratory in which to test their hypotheses and verify them or reject them. This type of test is rarely possible in the case of the evaluation of alternatives, for it is more realistic to compare the effectiveness of specific alternatives under conditions which will prevail in the future or which existed in the past.

The process of evaluating management alternatives on the farm is based on logic and on examination of actual outcome, in conjunction with knowledge of past experiences. More specifically, comparative budgets provide a basis for estimating the income potential of different management alternatives. Other considerations, such as risk, personal preference, and strategies for dealing with individuals, are generally handled with less formality and greater subjectivity.

SELECTING ALTERNATIVES

The final selection of one of the alternatives is based on the manager's determination of relative priorities. Few can replace the farmer in evaluating alternatives at the moment the decision is made, for the farmer's frame of reference is based on a scale of values different from that of people outside the farm. Frequently, administrators or farm managers assume this responsibility on their employers' farms, thus playing the role of "outsiders" who assume certain responsibilities related to their own scales of values rather than those of the owner.

In the case of community enterprises, this function falls to the administrative council or other body created for this purpose.

TAKING APPROPRIATE ACTION

If the selection of an alternative fits in with a policy, general plan or program, the manager will probably have to make repeated use of the analytical phase of management in order to determine the details of action implied by the decision taken. If the selection is well defined and specific, the next stage is the implementation of the action necessary to carry it out. For the farmer-operator, the implementation of action may involve merely deciding to take a certain action, such as going to the stables to milk the cows. In community enterprises, the analytical, executive and action functions should be assigned to different individuals, which means that it is necessary to have communications and written orders of all actions involved in the plans. This is accomplished by various departments and committes created for these purposes. The basic elements of the management process, however, are identical for both cases.

EVALUATING RESULTS

The need to analyze problems and take decisions is a direct result of changes in the world. Managers would have little or nothing to do if gradual changes did not take place in people, resources and technology, for this would create an ideal static situation, in both personal and business matters. The higher the rate of constant change, the greater the need for a manager.

The evaluation of the outcome can be considered the final stage of the management process once the decision has been taken. If the process has functioned properly, no problems will arise. However, if problems should occur, the manager would have to return to the first stage of the management process in order to pinpoint the source.

SPECIAL MANAGEMENT PROBLEMS IN AGRICULTURAL ENTERPRISES

The decision-making process in associative enterprises is somewhat more complicated than in family-run farms managed by the owners. The principal cause of this difficulty is that the responsibility for decisions is shared by a certain number of campesinos.

Even on the family farm, decisions concerning production are not independent of considerations of family consumption. Labor and capital have alternative uses and can be employed either to increase the production of the business or to improve the family's standard of living, whether directly or indirectly.

On many occasions campesinos have to choose between making investments to boost production and changing the level of immediate consumption, such as more cattle for the business versus the enjoyment of more comfort or a higher level of consumption in the home. Under these conditions, each decision must be evaluated in terms of its short-term effects on the life of the family or the community and on the productivity of the agricultural enterprise.

MANAGERIAL PROBLEMS IN ASSOCIATIVE AND STATE ENTERPRISES

The creation of new enterprises, both associative and state-run, creates problems involving the enterprise itself, the general policies of the country and public administration. These problems stem from the political-economic orientation of the country in question, from the resultant administrative structure, and from the beliefs, values and cultural levels of the campesinos.

If we examine the roles of power in the three types of enterprise (see Figure 7) we find that the campesino is converted from simple worker into owner-operator. This signifies that his or her participation becomes essential in the operation and decision-making process of the enterprise.

One of the problems which arise in this respect is the fact that the campesinos have received no training for playing these new roles. This has led the government to create broad and very diverse education agencies and programs, such as the National Center for Training and Research for Agrarian Reform (CENCIRA) and the National System of Assistance to Social Mobility (SINAMOS) in Peru.

Another related point is the representativeness of the various self-managed enterprises. In some cases the campesino delegates do not know how to meet the expectations of their fellow members and they assume bureaucratic bad habits or take up certain political leanings with the resultant harm to the enterprise and their fellow members.

Another type of problem stems from the inability of public administration to adapt to the new needs which arise with the associative enterprises. For example, in Cuba at the begining of the revolution, decision-making power was successfully centralized. In 1967 the policy of regionalizing agricultural production introduced the decentralization of management authority and the elimination of various bureaucratic ranks. At the same time a process of local planning was initiated, tending gradually to eliminate centralized planning (Gutelman[11]).

In the early stages of the creation of associative enterprises, the legislation is sometimes unclear or incomplete. This presents problems, making the operation of the enterprises more difficult. There is evidence that this type of problem has occurred in Colombia (Orchard[17]).

State enterprises or public administration units such as local zoning boards, regional corporations (such as the Regional Autonomous Corporation of the Cauca Valley (C.V.C.) in Colombia), irrigation districts and others, operate under the authority of an administrative body. This body is responsible for taking decisions that represent the interest of the members of the enterprise. Management

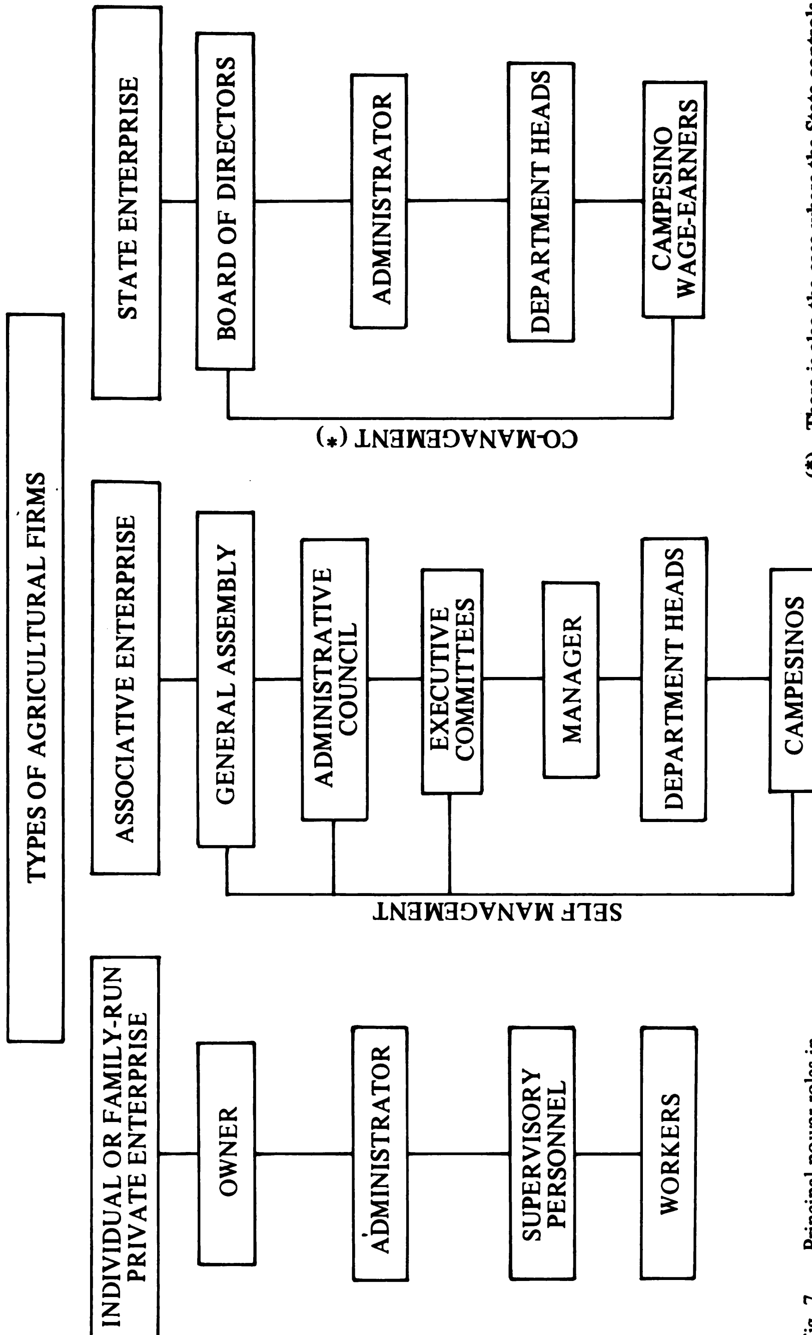

Fig. 7. Principal power roles in different types of agricultural firms.

(*) There is also the case where the State controls all the resources and consequently has all the power.

speaks with only one voice, although it is generally very difficult to reconcile and reflect faithfully the sometimes conflicting interests of the members.

THE GENERAL ECONOMY AS A COMPLEX UNIT OF ADMINISTRATION

The process of developing and evaluating agrarian reform is actually the task of planning for a very complex administrative unit, that is, the general economy as a whole. Of course, the economy comprises thousands of complex and interrelated administrative units, public as well as private.

Planning the economy requires an understanding of the way these operating units react in the aggregate under various alternative conditions. But the behavior of the overall economy in this type of planning cannot always be determined by simply adding up current knowledge of the behavior of individual operating units (enterprises).

The general economy is characterized by interdependence among the different operating units. Market prices, and the mechanism of supply and demand by which they are determined, are important factors forcing producers and consumers to make changes and adapt themselves to the general behavior of all other operating units. Social institutions also undergo a continuous process of readjustment caused in part by general market behavior. For example, low prices in the free market frequently stimulate severe political pressure for price fixing.

Under these circumstances, a study of individual operating units can provide only tentative conclusions. Such studies are based on certain assumptions concerning economic behavior, but the basic assumptions must be revised so as to remain consistent with the tentative conclusions of the study of selected units.

For example, changes in milk production could be studied on the basis of certain assumptions about future price relationships. If individual case studies suggested the probability of a drastic increase in milk production in the area under study, it would be necessary to review and alter original assumptions and undertake a new analysis of operating units. Once expected changes have been brought into line with assumed prices, it becomes possible to undertake further studies and include increasingly broader sectors of the economy.

These studies could be based initially on the organization of dairies in one given area, expanded to include dairy operations throughout the country, extended to studies on food production, and so forth, until studies are being made of problems of the overall economy.

The direct analysis of the general economy is an alternative method preferred by many researchers. It involves constructing and evaluating equations based on historical data to represent the relationships between the principal groups of inputs and products in the various sectors of the economy. This method tends to oversimplify the fundamental relationships under study. General analyses can be reduced to appropriate simplified forms, but it would be unrealistic to omit the physical and institutional relationships of the resources involved. These resources have been carefully organized, in thousands of individual agricultural enterprises, into a particular combination of soils, equipment, machinery, construction, human abilities and management objectives. These units are the sphere in which decisions are taken concerning resource use, which is why so many methods for studying the operating units (enterprises) have been emphasized.

SUMMARY

Management functions, such as planning, organization, resource gathering, direction, coordination, and communication and control, must be adopted in agricultural enterprises.

Planning determines what will be done in the future. It includes goal-setting and the adoption of objectives and the means for achieving them. It sets guidelines and develops programs of the activities for the various types of production in the enterprise.

Organization gives managers the tools they need to administer the enterprise. It combines necessary activities in administrative units so work plans can be carried out, and it establishes relationships between the executives and the workers in the units.

Assembling resources involves providing the business with the three major resources: land, labor and capital. In addition, it provides the firm with the internal factors that the farmer can obtain and put to use and with the external factors needed by the enterprise for its operation.

Direction means guiding and managing daily operations. It includes authority and capability for giving orders and making sure the business functions normally.

Coordination synchronizes and unifies group efforts. Effective coordination must include: simplifying the organizational structure, harmonizing business policies with plans, maintaining a good communications system, using job descriptions and concrete instructions, and encouraging voluntary coordination. Communication is also an important function of the agricultural enterprise and consists of transmitting information or orders among the various elements and levels of the organizational structure. It should be a two-way channel, from higher levels to lower levels and vice versa.

The purpose of control is to verify that the output of operations or activities corresponds to the plans. It implies the establishment of measures for correcting errors and improving fulfillment of plans. Gantt diagrams and PERTs are two important tools in the process of the planning and control of the agricultural business.

The decision-making process requires a well-trained manager who has mastered both technical knowledge and management techniques. There are seven stages in the management process: identifying the problem, gathering or observing data and facts, identifying alternatives, evaluating alternatives, selecting the best alternatives, taking appropriate action and evaluating results.

The opening of a new agricultural enterprise brings with it certain managerial problems. Some are due to the fact that campesinos lack the management training they need to handle the new functions required of them in associative enterprises when they move from wage-earners to owner-operators. Other problems have to do with the lack of adequate service structures and the failure of public administration to adapt to the new situation created by the associative enterprises. Finally, problems stem from the lack of needed legislation and the vagueness of existing laws.

The overall economy can be seen as a complex management unit. However, it is much more than the simple sum of all the productive units of the country.

QUESTIONS

1. Visit an agricultural enterprise and try to obtain the following information:

   a. Briefly explain the managerial functions most important to the enterprise.

   b. Analyze the administrative structure and briefly describe the degree to which the objectives of the enterprise influence its organization.

   c. Briefly explain whether or not the structure of the enterprise includes the basic principles of organic structure.

2. Prepare a list of the qualifications needed by the manager of an agricultural enterprise.

3. List and briefly comment on the advantages of: effective organization; good direction; efficient coordination.

4. Give a brief description of the management process and identify problems which arise in community enterprises.

5. Briefly describe some of the problems that appear when the general economy is viewed as a complex unit of management.

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CHAPTER 3

BASIC PRINCIPLES OF ECONOMIC ANALYSIS IN THE AGRICULTURAL ENTERPRISE *

Farm management as it has been defined in this book is not a pure science. Its role is to integrate the use of various sciences for analyzing the administrative, social, economic and technological problems of the enterprise. Since a large part of the farm decisions are of an economic nature, an understanding of simplified models of economic theory can help the farmer and the researcher develop a better basis for judgement and avoid errors in the analysis of problems in the agricultural enterprise. If a good understanding of these models is achieved, it becomes possible to apply simple techniques appropriate for the identification of the most promising management alternatives, and for preliminary examination of those alternatives, in order to arrive at the best possible decision.

CONTRIBUTIONS OF ECONOMIC THEORY

In general, economic theory has concentrated more on the type of equilibrium that could be achieved in the absence of change, than on the change process itself. As such, this body of theory provides very little explanation of the behavior of producers confronted with conditions of constant change. In addition, some of the most useful theories could be better defined as simplified generalizations of very complex interrelationships, rather than specific formulas describing exact mathematical relationships.

The theoretical principles for analyzing the agricultural enterprise are known as theory of the firm. It includes concepts of fixed, variable and marginal costs; of price structure; and of total, average and marginal revenue. It also deals with the way a rational manager establishes relationships of equality or proportionality between the marginal costs and revenues of all inputs and outputs. This chapter will describe some of the basic principles behind this "rational"

(*) This chapter is a summary of some of the most widely known principles of economic theory. The various subjects are introduced according to the approaches used by the following authors; Bishop and Toussaint[1], Dillon[2], Heady[6], Leftwich[7], Stigler[10], Vincent[11], and Rodriguez Alcaide[9].

managerial behavior for the maximization of income. These principles are: variable proportions, or the factor-product relationship; marginal analysis and cost functions; the principle of substitution, or the factor-factor relationship; the product-product relationship and principles of comparative advantage.

In our analysis of these principles, we will assume that a state of perfect competition is present, that is, that the following conditions have been satisfied:

– Each economic unit (enterprise or family) should be small enough in proportion to the size of the total market not to exercise perceptible influence in the buying or selling prices of uniform products.

– All markets should be free from institutional interference. In other words, no restrictions should exist on prices, mobility, or other factors.

– All economic units must have access to the information they need.

THE LAW OF DIMINISHING RETURNS OR VARIABLE PROPORTIONS

In order to apply this principle, also known as the factor-product relationship, we must first review several basic concepts.

Production or response functions

The production or response function can be defined as the ratio between the quantity of factors (resources) per unit of time and the amount of product obtained from these factors.

The output of the firm depends on the quantities of inputs used in the production process. This relationship between input and output can be represented with a production function, or a mathematical relationship in which the quantity of a product (Y) depends on the quantities of input ($X_1, X_2, \ldots, X_n$), or:

$$Y = f(X).$$

Assuming that:

Y = output (wheat)
X = input (fertilizers, land, etc.)
f = function,

we can state that $Y = f(X_1, X_2, X_3, \ldots, X_n)$, or that the product Y is a function of, or depends on, the quantities of land, fertilizers and other factors used in production.

The producer must decide how to combine resources to obtain a given output. Resources can be combined by defining one factor as variable and the others as fixed, which is the simplest decision-making technique. For example, one hectare of land, two workers and 100 kilograms of seed represent fixed factors or resources; fertilizer, then, is the variable factor. This type of relationship is called the "Law of Diminishing Returns" or of variable proportions. "If the input of one resource is increased by equal increments per unit of time while the inputs of other resources are held constant, total product output will increase, but beyond some point the resulting output increases will become smaller and smaller." (Leftwich, 7, p. 109, see Fig. 8).

Stingler[10] stipulates certain complementary assumptions of this law:

– It refers to quantities per unit of time.

– It is a technological law which shows only the relationship between factors used (hours of work, hectare-years) and production (kilograms of wheat).

– Because it is a technological law, it cannot provide direct assistance in determining the optimum quantity of a factor to be combined with a given quantity of another factor.

– The various factors are measured in uniform units.

This function can be illustrated as follows: a farmer is considering the amount of fertilizer to use in wheat production. He determines fixed values for specific quantities and qualities of the other factors involved. The equation is:

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

and the wheat yield thus depends on the variable quantities of fertilizer, where the other factors $(X_2, X_3, \ldots, X_n)$, such as land, labor and seed, remain fixed. The slash in the equation means that the factor X_1 is variable while the other factors are constant.

This function describes a farmer's simplest decision. Total physical product is given by the TPP curve. The lower part of the figure contains two other curves, the marginal physical product curve, MPP, and the average physical product curve, APP. The APP is defined as the ratio of total output and the quantity of resources used to

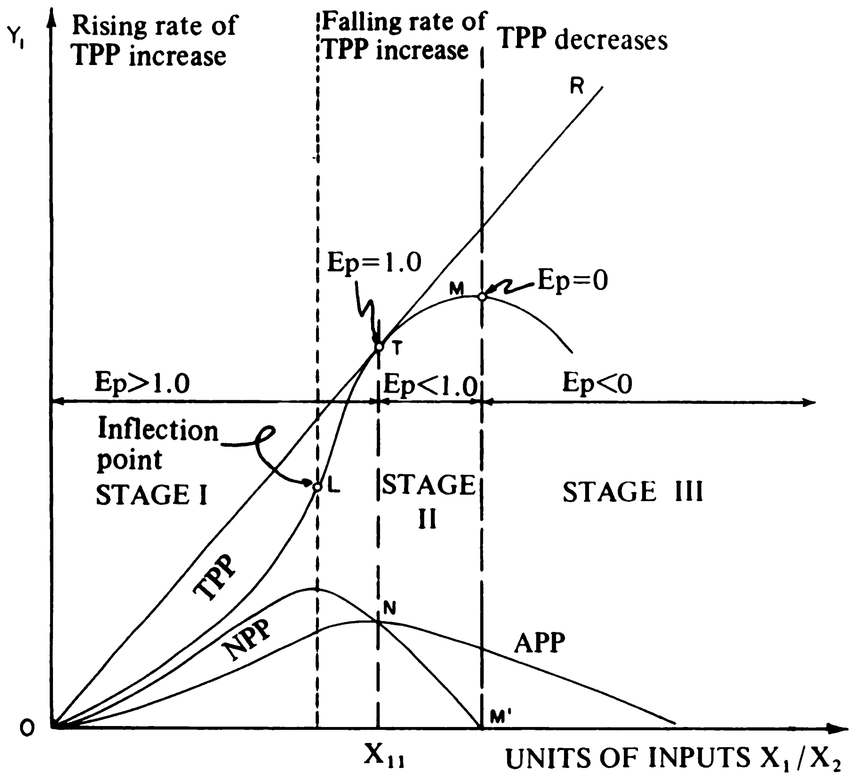

Fig. 8. Factor-product relationship. Total physical product (TPP), marginal physical product (MPP) and average physical product (APP). Production stages.

achieve a given level of production. The MPP, marginal physical product curve, is defined as the change in total output for each additional unit of variable factor X_1, and is expressed as: $\frac{\Delta Y}{\Delta X}$.

If $Y = f(X_1/X_2, X_3, \ldots, X_n)$,

$$\text{Then APP} = \frac{Y}{X} = \frac{f(X_1/X_2, X_3, \ldots X_n),}{X}$$

and the marginal physical product will be the first derivative of the base function. This curve reaches its maximum point immediately below point L on the total physical product curve, TPP; this point L is called the inflection point of the TPP curve, and it occurs where the rising rate of total product increase reaches its highest level.

If we follow the marginal physical product curve, MPP, we find that it intersects the average physical product curve, APP, at point N. This point N represents two important factors. First, the average physical product curve is obtained by dividing total physical output by units of input, so that the average product at X_{11} is equal to OT/OX_{11}, or the slope of line OT. Point X_{11} gives the steepest tangency line that can be drawn from the origin to the total product curve. Therefore, at point N the average physical product is at its maximum.

The second important aspect of point N is that at this level of input use, the average physical product, APP, and the marginal physical product, MPP, are equal, and this is the point at which Stage I finishes and Stage II begins. At point M' the marginal physical product curve MPP intersects the horizontal axis and has a value of zero. This point has the same X-value as M, the point at which total physical product TPP reaches its maximum and begins to fall off. This is the point at which Stage III begins.

IRRATIONAL PRODUCTION. No level of input used in Stage I is economical because the benefits (income) to the individual farmer or national production can be increased by applying greater quantities of variable factors to the set of fixed factors. This means that average physical product, APP*, increases when the level of variable factors is increased. Instead of cutting off applications of variable factors to the fixed factors during this first stage, the farmer or resource manager can always increase the product obtained from the resources by modifying the mix of fixed and variable resources used during the first stage. In other words, it may be possible to increase output by leaving idle or discarding part of the available fixed input.

For example, suppose irrigation water is an abundant resource in a given region and that the farmers can use all they want at no additional cost. In such a situation, the farmers, rather than flooding their land, would use the quantity of water they needed to obtain the maximum yield from other factors such as land, labor and capital. Consequently, a producer interested in maximizing income, as long as production remains profitable, will choose to apply variable factors, thus achieving at least the greatest average physical product.

The third stage also represents an irrational level of production. This is the stage at which total output drops, that is, marginal physical product, MPP (the quantity of additional output obtained from each additional unit of input), is negative.

(*) The average physical product curve, APP, represents the efficiency of the use of the variable resource.

No resource mix can make operations advisable at this stage since additional inputs only reduce total product. The point at which marginal physical product reaches zero represents the maximum quantity of variable factors that can be applied in combination with other fixed factors.

Producers often combine their resources or factors in the proportions defined for stages I or III of the production functions. This is because they do not have a clear understanding of production ratios. In many cases, crops never reach the second stage of production because farmers use insufficient quantities of nutrients (calcium, potassium, phosphorous). They would find, if they increased their use of these elements, that they could increase average output. Other producers operate entirely in the third stage. This occurs, for example, with poultry farmers who maintain excessive numbers of hens in the laying shed.

RATIONAL PRODUCTION AND RESOURCE DISTRIBUTION. Regardless of input and product prices, it is evident that only the second stage of production can be economical. In this stage, total output is on the increase; marginal output is falling and, although positive, is below average output, which is also decreasing. Producers interested in maximizing their income should operate within this rational production stage. Nevertheless, it is impossible to determine the particular level of production or the optimum quantity of inputs to be used in this stage, based exclusively on the production function; it is also necessary to know input and product prices, a topic which will be discussed later.

PRODUCTION ELASTICITY, OR COEFFICIENT OF PRODUCTION. Another concept which applies to the input-output production function is elasticity of production. According to Heady[6], this is the ratio between the percentage change in output Y and the percentage change in input X. It is expressed as:

$$Ep = \frac{\%\text{ change in Y}}{\%\text{ change in X}}$$

Its mathematical expression is:

$$Ep = \frac{\frac{\Delta Y}{Y}}{\frac{\Delta X}{X}} = \frac{\Delta Y}{\Delta X} \cdot \frac{X}{Y}$$

But $\frac{\Delta Y}{\Delta X}$ = MPP, where MPP equals Marginal Product

and $\frac{Y}{X}$ = APP, where APP equals Average Product

Therefore: $$Ep = \frac{\Delta Y}{\Delta X} \cdot \frac{X}{Y} = \frac{MPP}{APP}$$

Elasticity of production is greater than 1 during the first stage, until the average product APP reaches its maximum. At this point average product is equal to marginal product, that is, MPP = APP, and elasticity of production is equal to 1. The MPP then falls below the APP, and the elasticity of production is less than 1 between this point, at which the APP is at its maximum, and the point of maximum total product Y. Finally, it becomes negative as total product diminishes, that is, when the MPP is less than zero (see figure 8).

Optimum level of input use

Assuming that P_Y is the unit product price, we can multiply physical products (PPs) by P_Y (price of Y) to obtain the value of total, average and marginal products.

In such a case, the three physical product curves explained above remain the same (see Figure 9), only now they are called total product value (TPV), marginal product value (MPV) and average product value (APV). Consequently the Y-axis has a symbol (P_Y) for product price.

Line P_X in Figure 9 represents the factor price of X_1 or the cost of each additional unit of X_1 (which is a constant in this case). $P_{X_1} = MC_{X_1}$ tells us that the input price is equal to the marginal cost, that is, the cost of adding an additional unit to total product.

The point of greatest profit (PGP) is reached when the marginal product value, MPV, equals the price of input X_1, that is, where price equals marginal cost (MC_{X_1}).

The point of greatest income occurs when the cost of additional input equals the increase in income. If delta X_1 (ΔX_1) is the change in X_1, and delta Y_1 (ΔY_1) is the change in Y_1 produced by adding one additional unit of X_1, the maximum income is obtained when:

$$P_{Y_1} \cdot \Delta Y_1 = P_{X_1} \cdot \Delta X_1 ,$$

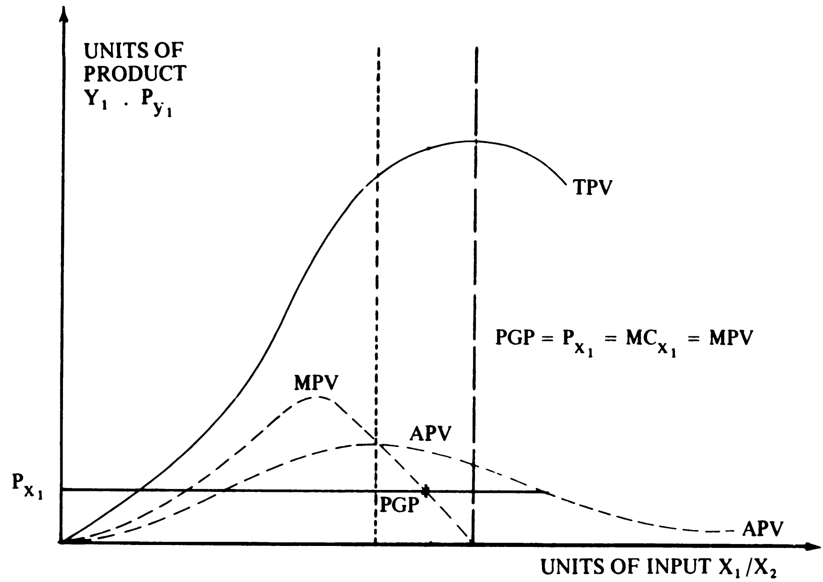

Fig. 9. Total, marginal and average value curves. Location of point of greatest profit (PGP).

that is, when the additional income obtained by adding the last unit of input equal the costs incurred thereby. This indicates that the ratio of input price to product price is equal to the marginal product:

$$\frac{P_{X_1}}{P_{Y_1}} = \frac{\Delta Y_1}{\Delta X_1} \text{ or } \frac{P_{X_1}}{P_{Y_1}} = MPP$$

thus: $$P_{X_1} = MPP \cdot P_{Y_1} \text{ or } P_{X_1} = MVP$$

Effects of price changes

Prices of inputs and products are subject to variables which, acting independently or together, cause them to undergo frequent changes. The price ratio (P_{X_1}/P_{Y_1}) is very important for the producer who wants to determine the optimum input level. If P_{Y_1} rises, the ratio P_{X_1}/P_{Y_1} falls. In order to make the marginal product ($\Delta Y_1/\Delta X_1$) equal to the new price ratio, the quantity of X_1 must be increased. On the other hand, a drop in P_{Y_1} causes the ratio P_{X_1}/P_{Y_1} to rise, and X_1 should be decreased. Changes in the price ratios of inputs or products stimulate changes in production. The degree to which price changes affect input levels depends on the nature of the production function.

Technological differences

The input-output relationships or response functions are significant only for products and inputs which are uniform. A given resource combination is also assumed to exist. However, production functions may vary sharply in spite of the use of identical resources and products. Such variations in the production function can be caused by differences in technology.

Figure 10 shows the physical production functions for two different levels of technology. Curve A gives the production function for the successive applications of unskilled labor. Curve B is the production function for successive applications of skilled labor. At point L the level of input use (labor) is the same (OL), but as we can see in Figure 10, production is greater for curve B, reaching point R with the use of improved technology.

This type of analysis is important not only on the individual production level, but also on the multi-farm or project level. It has many implications ranging from changes in costs to changes in the size of the enterprise or the project.

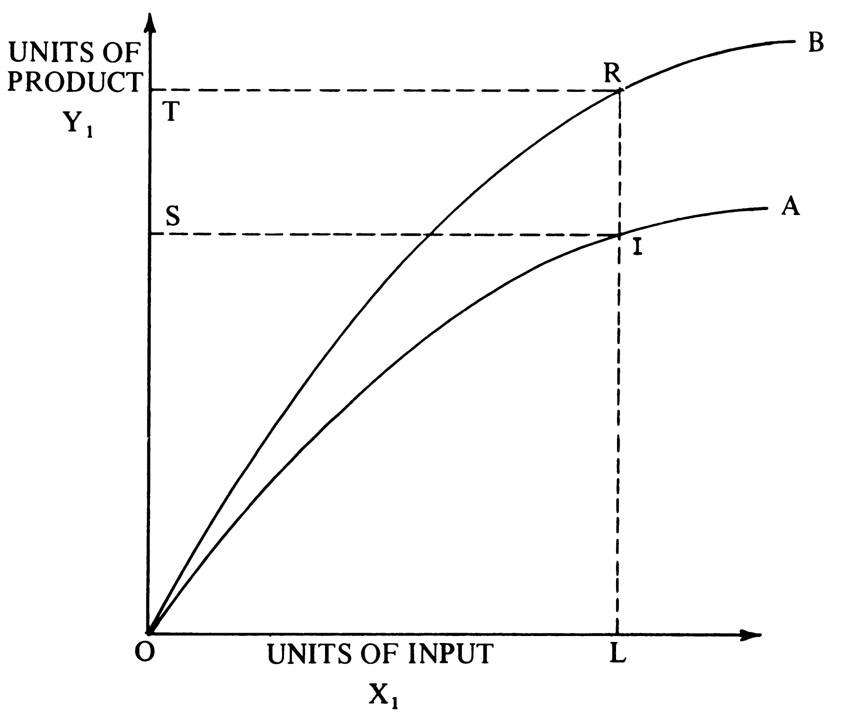

Fig. 10. Physical production functions with different levels of technology.

Types of production or response functions

Generally, the true algebraic pattern of responses the farmer is interested in studying is unknown. The most common approach is to adapt an existing function to available data. The types of functions most commonly used, according to Dillon[2], are: the Cobb-Douglas function, the Spillman-Mitscherlich function, the Quadratic equation and other types of polynominal equations.*

PRODUCTION COSTS IN THE AGRICULTURAL ENTERPRISE**

The term "cost" is generally understood as monetary disbursements or expenditures for the acquisition of inputs needed in producing goods and services. This expenditure is directly related to the structure of production which, in turn, is defined by the production function. Thus, the production function relates output to the volume of input, while the cost function relates input costs to input use, reflected in production levels.

Cost functions, like production functions, refer to a specific period of activity. Consequently, the idea of production costs for a given item refers to expenditures incurred in producing a particular quantity of the product over a given period of time.

(*) The most widely used form of the Cobb-Douglas is $Y = aX^b$ where:

X = variable resource

Y = product

a = a constant;

b = the transformation rate for different values of X (the equation is calculated logarithmically).

The Spillman-Mitscherlich function is experimental and bears the name of its creator. It takes the following form: $Y = M - AR^x$ where:

Y = total product

X = input (total resource)

M = maximum total product which can be achieved by using the variable input

A = total product increase to be achieved by increasing X

M-A = the level of production using only fixed resources, with variable input at zero

R = a positive constant, less than one, representing the ratio of consecutive increments of the total product.

(**) This section follows and summarizes the guidelines of Leftwich[7], Chapter 8.

The most common costs for any enterprise are: rent, seed, fertilizer, machinery, equipment and labor. Some of these may be fixed for a given period, but variable over a longer period. Thus, in the study of production costs, it becomes necessary to distinguish between the "short run" and the "long run." The short run is too brief for the enterprise to vary the quantities of given resources. The long run is long enough for the producer to vary the quantity of all resources used during that time period. Over the long run the firm can vary its size or use its existing facilities more or less intensively to change production. Over the long run all resources are variable.

THE SHORT-RUN COST FUNCTION

Economic theory analyzes costs from two different points of view: a) total costs and b) unit costs.

Total Costs

The concept of total costs is important in the analysis of short-run production and prices. Total costs include three different categories: total fixed cost, total variable cost, and total cost.

Total fixed cost. Total fixed costs are incurred regardless of the volume of production during a given period. They are obligations assumed by the enterprise for the use of fixed resources, per unit of time. Total fixed costs are independent of the levels of production per unit of time, because in the short run there is no time to modify the use of fixed resources. For example, if the enterprise uses its own machinery, it must allow for amortization costs during its useful life. They are determined on the basis of a fixed quantity per unit of time and are independent of the level of production.

Total variable cost. Variable cost results from adding variable inputs to obtain production increases. In the case of agriculture, variable costs could include fertilizer, machinery, seed and labor.

Total cost. Total costs for the firm at various levels of production equal the sum of total fixed costs and total variable costs for the production levels in question.

Nature of the total cost function. The shape of the total cost function is determined by the production function, assuming that the price the producer pays for inputs does not vary with the quantity purchased. The relationship between the production function and the total cost curve appears in Figures 11 and 12. Of course, as was pointed out earlier, there are certain fixed costs. They can be represented by moving the total product curve Y to the right at a distance equal to the value of fixed costs, or OA. Fixed costs change the position, but never the shape, of the curve.

For analyzing optimum production levels for the enterprise, units of cost are plotted on the Y-axis and units of production,on the X-axis (see Figure 12).

Total fixed cost (TFC) is shown as a straight line because, in spite of the production increase of units of Y, fixed costs remain constant.

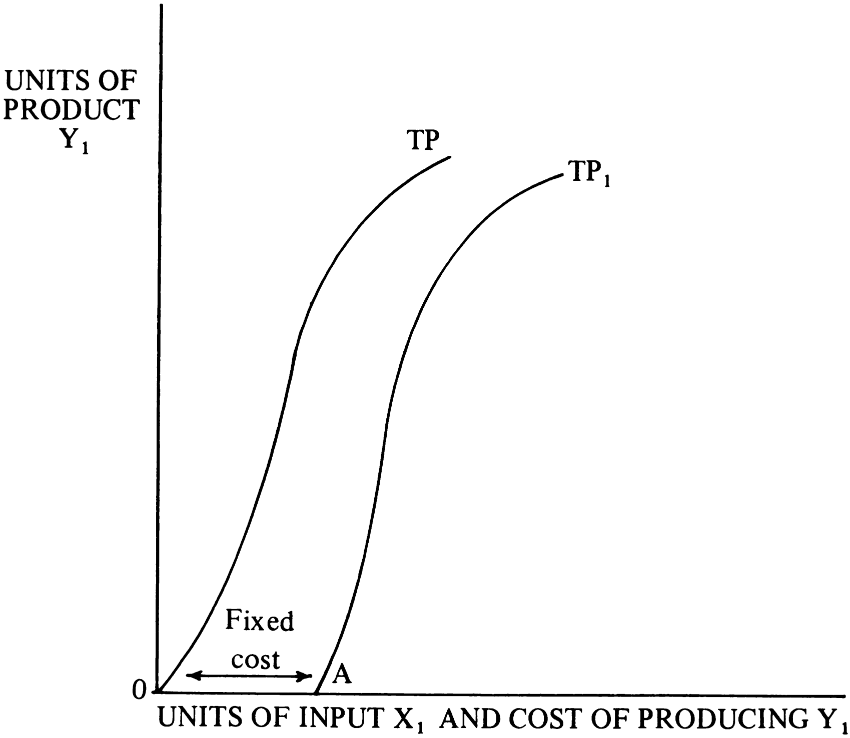

Fig. 11. Relationship of the total cost curve to the production function where $Y = f(X_1)$.

The total fixed cost curve is added to the total variable cost curve (TVC) to give the total cost curve (TC) where TC = TFC + TVC.

As the level of variable factors or resources increases, with other resources remaining fixed, the law of diminishing returns or variable proportions goes into effect (see Figure 12). When small quantities of a variable input are in use, this tendency makes itself felt during the first stage of the production function, when yields and marginal physical product are rising. When the amount of variable input is increased, yields begin to fall off. This shows up in the shape of the total variable cost curve. As quantities of variable resources become greater, the marginal physical product begins to slip and the total

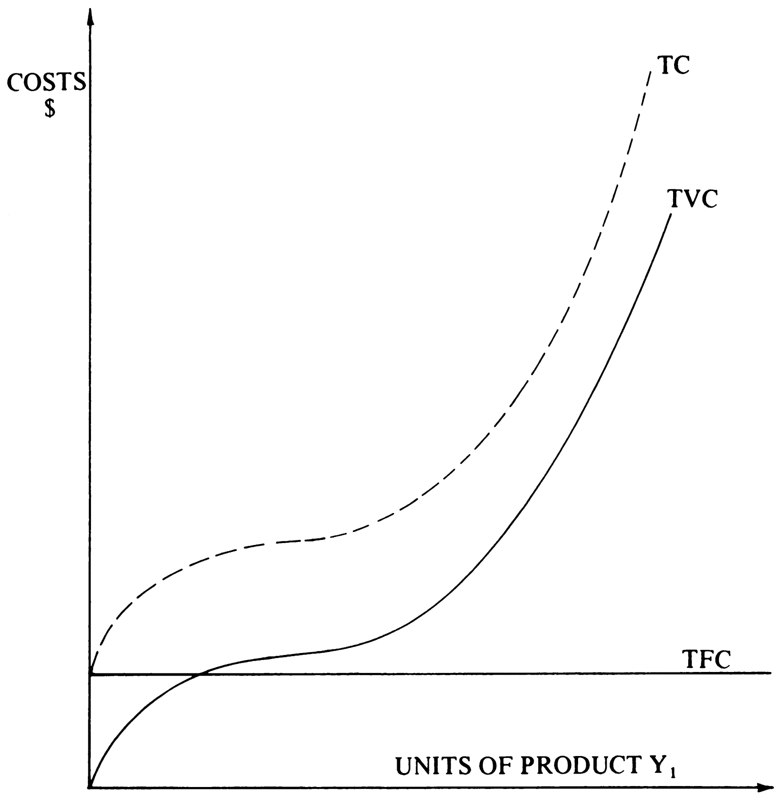

Fig. 12. Total cost, total variable cost and total fixed cost.

variable cost curve becomes concave downward. At a certain point in production, the fixed resource (for example, a hectare of land) reaches its absolute maximum capacity, and the total variable cost curve becomes concave upward. Additional injections of the variable resource no longer lead to increases in production.

Total costs are important to the firm fcr determining net income during a given period of production. The net income figure is calculated by subtracting total costs from total revenue. Such an analysis, however, is of little value in the decision-making process and does not give the optimum quantity of resources to be applied to fixed factors. The manager involved in the decision-making process is actually much more concerned with unit costs.

Unit costs

Unit cost curves are used more than total cost curves to determine prices and optimun production. Unit cost are derived from total costs on the basis of the same information and provide for a clearer interpretation of the price and production patterns. Unit costs include: average fixed cost (AFC), average variable cost (AVC), average total cost (ATC), and marginal cost (MC) (see Figure 13).

Average fixed cost. This is obtained by dividing total fixed costs by total output (Y) at a given level of production.

$$AFC = \frac{TFC}{Y}$$

As the firm's production increases, average fixed cost (AFC) decreases. Total fixed costs do not vary with the rise in the level of production; as a result, average fixed costs are less when output is high, for we are dividing a fixed quantity by an increasingly larger figure. Therefore, the average fixed cost curve (AFC) decreases to the right to infinity. As more units are produced per unit of time, the average fixed cost curve (AFC) approaches but never reaches the output axis. This is why certain enterprises maintain very high fixed

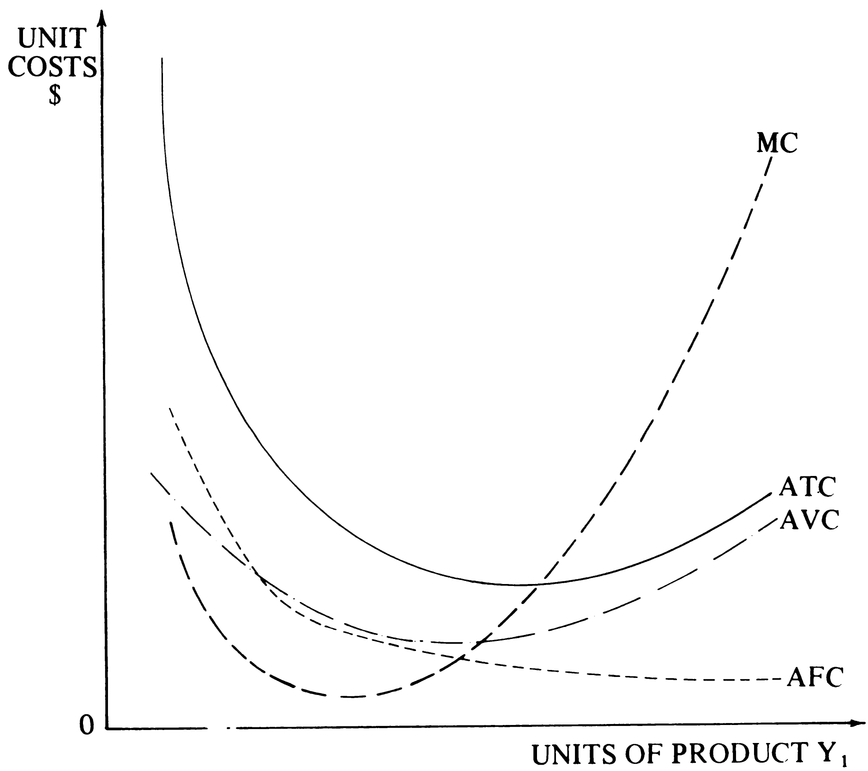

Fig. 13. Unit costs.

costs in the attempt to maximize production as much as possible. Agricultural managers rarely appreciate the economic implications of this function.

Average variable cost. Average variable costs are obtained by dividing total variable costs by the corresponding production level:

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

Generally, the curve is U-shaped. An example of this would be a plant operating on a fixed scale in which the only variable resource is labor. If only one worker were employed, output would be very low; if a second worker is added, yearly production is more than doubled. In other words, average output per worker increases when another worker is added. Doubling the variable cost (labor) more than doubles the production and, as a consequence, the per-unit production cost (average variable cost, AVC) drops. This is why, throughout stage I of production, output per worker is on the rise while average variable costs (AVC) are on the decrease. If enough laborers are hired to move into stage II of production, the average output per worker begins to decline as the average variable costs increase.

Average total cost. The average total costs for a given level of production can be obtained by adding the average fixed costs (AFC) to the average variable costs (AVC):

$$ATC = \frac{TC}{Y} \quad \text{or} \quad ATC = AFC + AVC$$

Graphically, the average total cost curve (ATC) is U-shaped, but the actual form of the curve depends on the efficiency with which variable resources are used.

Marginal cost. Marginal cost (MC) can be defined as the increase needed in total costs to increase output by one unit. It would be equally true to define marginal cost as the rise in total variable costs that occurs when output is increased by one unit. This is because production increases require identical rises in both variable and total costs. Therefore, marginal cost is totally independent of fixed costs.*

Relationship between marginal cost (MC), average total cost (ATC) and average variable cost (AVC)

The relationship between the marginal cost curve and the average cost curve is based on the total cost curve. As production increases,

(*) Mathematically, MC is the first derivative of total cost TC so that:
$TC = f(X)$; $MC = \frac{\delta TC}{X}$; $MC = f^1\ (X)$.

the average cost curve decreases and marginal cost (MC) falls below average total cost (ATC). At a given point, average total cost (ATC) reaches a minimum, equal to marginal cost (MC). The average total cost curve (ATC) and the average variable cost curve (AVC) begin to drop when the marginal cost curve (MC) falls below them, and they rise when the marginal cost (MC) is above them. The continuous nature of the cost curves indicates that the variable input and the product are divisible (see Figure 13).

ALTERNATIVE COSTS OR OPPORTUNITY COSTS

It has been established that productive resources are scarce and limited. When the producer uses them in the production of certain goods, they cannot be used to produce other goods. For example, a certain quantity of labor can be used in the production of tractors or automobiles. If it is decided to use the available labor to produce tractors, society is necessarily giving up the production of automobiles which this labor would otherwise have been capable of producing, and instead, tractors are produced. Economists define the opportunity cost of a given product as the value of alternative goods which are not produced because the resources are being used to produce the given product. The actual cost of resources to the firm is the value they possess when used in the best alternative. This concept is called "alternative cost" or "opportunity cost."

IMPLICIT AND EXPLICIT COSTS

Explicit costs are resources purchased or rented by the firm. For example, payments for raw materials, general expenses, labor and salaries are all explicit costs. Implicit production costs are the costs of resources belonging to the firm and often overlooked in expense calculations. This occurs when no salary is imputed to the owner of the enterprise, but business profits are taken as payment for his or her work. As another example, the owners obtain certain benefits on their investments in machinery, tools and other goods.

Enterprise production costs are made up of explicit and implicit costs. In general terms, only explicit costs are considered firm "costs." But the cost of production from the viewpoint of the economist differs considerably from the "cost" concept maintained by the firm's bookkeeping operation.

SOCIAL COSTS AND BENEFITS

The concept of opportunity cost is applicable to both the private sector and the overall economy. The cost to the firm of using goods and services for a given purpose is the value of the benefits which might have been available if the goods and services had been put to an alternative use. Likewise, the social opportunity cost of capital is that rate of return at which all the capital in the economy will be invested.

These concepts are useful in an economic analysis for determining the social and economic return of enterprises or projects. The purpose of this analysis is to determine the overall return that the firm or the general economy will receive from all the resources which are used. It is not concerned with the social sector that will provide the resources or with the social sector to receive the benefits.

THE LONG-RUN AVERAGE COST CURVE (LAC)

The long-run average cost curve is defined by Stigler[10] as "the best average cost the producer can obtain by producing any given quantity, assuming he has sufficient time to make required adjustments."

A long-run average cost curve (LAC) can be constructed from any group of short-run average cost curves (SAC), as can be seen in

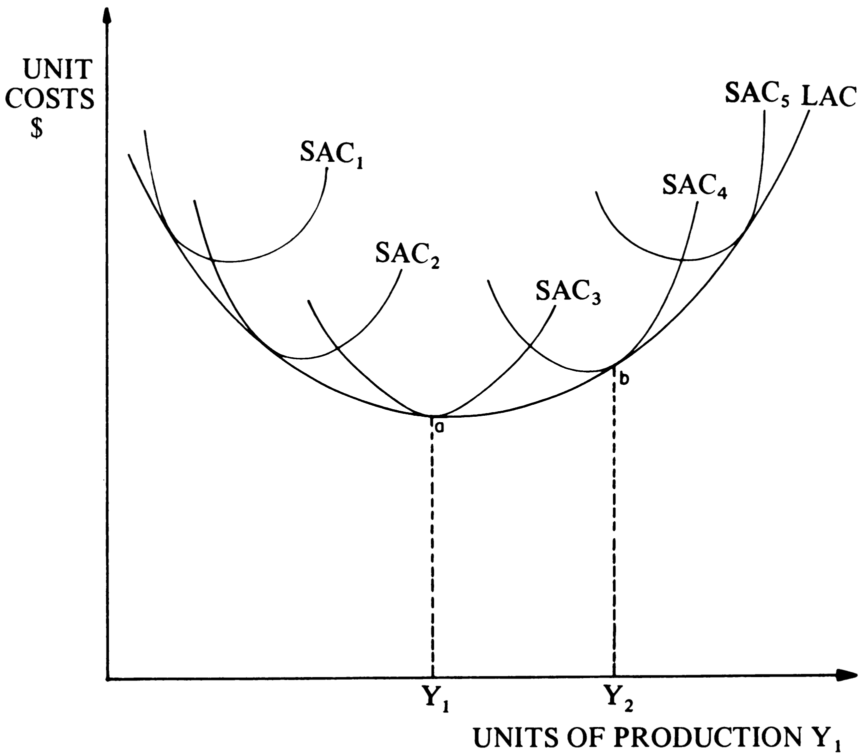

Fig. 14. Short-run and long-run costs.

Figure 14. The long-run average cost curve is the "envelope" of the short-run average cost curves; in other words, it is the only curve which is tangent to the short-run average cost curves when returns are continuous. It is at point of tangency (a) that operational costs reach their lowest level of all the short-run average cost curves; all firms with costs to the left of (a), such as firms 1 and 2, are operating at a size or scale below optimum.

Costs and benefits of economies of scale

Taking into account that this analysis is being made on the assumption of conditions of perfect competition, the long-term equilibrium of the enterprise would occur at point Y in Figure 15. Here the marginal revenue line (MR) is tangent to the lowest-cost curve of long-run average costs and therefore intersects the long-run marginal cost curve.

Each factor is at maximum profitability and thus can be maintained in production. Euler's Theorem can be applied to this equilibrium condition. This means that "total output would be distributed equally among the factors of production at this point, if each factor receives a return on its marginal product " (Rodríguez[9]).

The relationship between economy of scale and the size of the firm

The concept of economies of scale should fit into the context of possible changes in the number and size distribution of agricultural

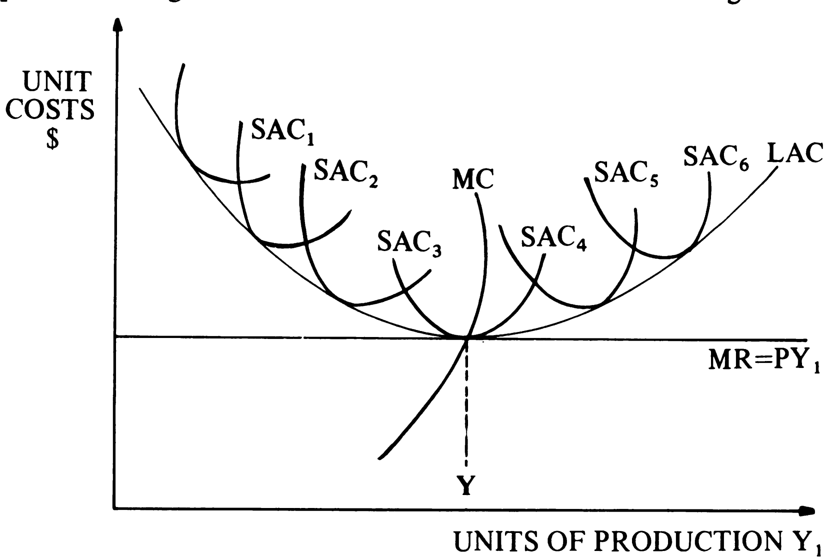

Fig. 15. Costs and benefits of economies of scale.

enterprises. Adjustments in size are not always determined by the nature of the long-run average cost curve, which depends on other factors such as the degree of dominance and control exercised over inputs by the firm, its solvency, and its potential control over additional inputs. For example, if steps are under consideration to increase the size of agricultural enterprises in a given zone by adding land area, the supply of available land must be taken into account. In addition, increases in the size of the firm affect the prices of products and inputs. These changes should be carefully studied in terms of the zones and regions of influence and economic advantages and disadvantages they may bring about.

Economies and diseconomies of scale*

For the most part, the long-run average cost function is a U-shaped curve. The decreasing segment corresponds to increasing returns according to scale, or economies of scale. Diminishing returns, or diseconomies of scale, appear on that part of the curve in which average costs are increasing.

Economies and diseconomies of cost, as examined here, are divorced from consideration of the source of costs. Any discussion of the size of the agricultural enterprise implies the idea of unit costs and their relationship to the production process. However, the individual operator is interested in average and marginal costs, and their relationship to total acreage, total stock or different sizes of the firm. Generally, when laymen refer to the size of an enterprise, they mean average costs for different acreages and the competitive advantage of large firms over small ones.

In the short run, variations in average cost reflect rising or falling returns; in the long run they reflect economies or diseconomies of scale.

Rodriguez Alcaide[9] discusses various cases of economies of scale in fattening calves, cotton production, irrigation, and egg packing.

The drop in unit costs that results from the scale of production is called economies of scale; when unit costs rise as a result of production scale, it is called diseconomies of scale.

Simple physical ratios partially explain the changes in unit costs of production that occur with variations in the size of the firm and volume of production. When physical yields increase, unit costs fall, while physically decreasing yields have the opposite effect. Nevertheless, other forces are also important in explaining the cost changes that accompany variations in the size of the firm and increases in the

(*) This section follows Heady[6].

volume of production. Certain cost economies can be obtained only with size increases that are proportionate with changes in machinery or other resources.

Economies or diseconomies of cost per unit of individual production can be internal or external; likewise, they can be monetary or technological.

Internal economies are achieved by size adjustments within the individual production unit; they are independent of shifts in the industry. External economies are achieved outside the production unit, which is dependent on shifts in the total industry, and such changes affect the firm only as a single part of the overall industry.

INTERNAL MARKET ECONOMIES (pecuniary) are associated with the large-scale purchase of factors (inputs). Better prices can be obtained when large volumes of an input are purchased than when small quantities are purchased by individual firms.

INTERNAL PHYSICAL ECONOMIES. This type of cost reduction arises mainly as the indivisibility of factors is overcome when size and output are increased. An example is the use of work simplification techniques and division of labor. Similar economies are achieved when the size of the firm is increased by use of different levels or forms of fixed factors. As explained above in the section on unit costs, the phenomenon of cost reduction occurs when the decline of per-unit fixed costs is greater than the increase in per-unit variable costs. Indivisibility also is overcome with the use of larger machines in big companies. Such machines cannot be used in small firms, but the costs of operating small machinery are relatively greater than the costs of operating large machinery.

INTERNAL DISECONOMIES IN AGRICULTURE are principally of a technical nature. Nevertheless, monetary diseconomies also exist. For example, there are cases of farms specializing in the production of cotton or other products in which, although available local labor is employed, it becomes necessary to bring in outside labor by offering higher wages. This situation is the inverse of the case described above in which large-scale purchases make price reductions possible. In this case the demand for a given resource or input is high, the product becomes scarce, and the price rises.

INTERNAL TECHNICAL DISECONOMIES occur when management (supervision and control) and space functions begin to act as handicaps and decrease the productivity of other resources. Another type of diseconomy occurs with uncertainty or risk, as in the case of pests or parasites. For example, if we take machinery as a fixed factor, steady increases in the acreage under planting reduce productivity, since the addition of more hectares limits the ratio between planting and harvesting time and the availability of labor and machinery.

EXTERNAL MARKETING ECONOMIES occur in the costs of the individual firm when the number and size of the farms facilitate the capacity of silos, mills, roads, transportation, and marketing channels to help reduce marketing costs. The organization of marketing cooperatives or processing firms can also help pull down costs.

EXTERNAL TECHNICAL ECONOMIES occur outside the individual enterprise when increased acreage under cultivation in a given area increases the efficiency of technical assistance services and thus helps eliminate pests, diseases and weeds. This in turn boosts productivity per unit of resources. Other external economies occur in irrigation districts and drainage projects. Irrigation dikes or drainage canals represent enormous costs which can be met only through great sacrifice by individual farmers making sizable outlays. By increasing the number and size of the firms using a dike or irrigation canal, the indivisible nature of the fixed costs of the installations makes it possible to distribute the burden over a higher volume of output.

EXTERNAL ECONOMIES become possible as size increases, either through adjustments in proportions or through shifts in the scale.

EXTERNAL MARKET DISECONOMIES. Marketing or monetary diseconomies occur when all agricultural enterprises increase their demand for fertilizers, pesticides, and other services provided by competitive industries. This use of additional resources by the farmers becomes possible only if higher prices are paid for inputs; this in turn increases unit costs of production.

EXTERNAL TECHNICAL DISECONOMIES occur only in irrigation projects when, at a given moment, increases in one farmer's use of water affect the availability of this resource for other farmers. This is most evident in pump irrigation projects when greater quantities of water are used for irrigation, the water level drops, and the cost of pumping water increases for neighboring farmers. Artificial rainfall can also cause diseconomies of a technological nature. In the case of soil erosion, an individual farm may suffer a drop in yield when irrigation ditches carry rain water from one farm to another.

INCOME FUNCTIONS*

One of the fundamental objectives of any business enterprise is to maximize income or minimize loss. A number of social objectives

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(*) This section includes elements from Leftwich[7].

also comes into play, but they will not be discussed here. This concept provides only a starting point for analysis.

Under conditions of perfect competition, the total revenue production function is a straight line with a slope equal to the product price. Net income is defined as the difference between total revenue and total costs.

Maximizing income, the total revenue curve and the total cost curve

In order to "maximize" income, we must compare total costs to total revenue at various possible levels of production. A producer anxious to maximize income should find the production level at which the difference between total revenue (TR) and total cost (TC) is the greatest (see Figure 16).

At some point less than N units of production, the slope of TR is greater than that of TC; the two curves diverge as production increases from R toward N. When production surpasses N units, the slope of TC is greater than that of TR and the curves tend to converge as production moves farther from N units. N is the optimum level of production.

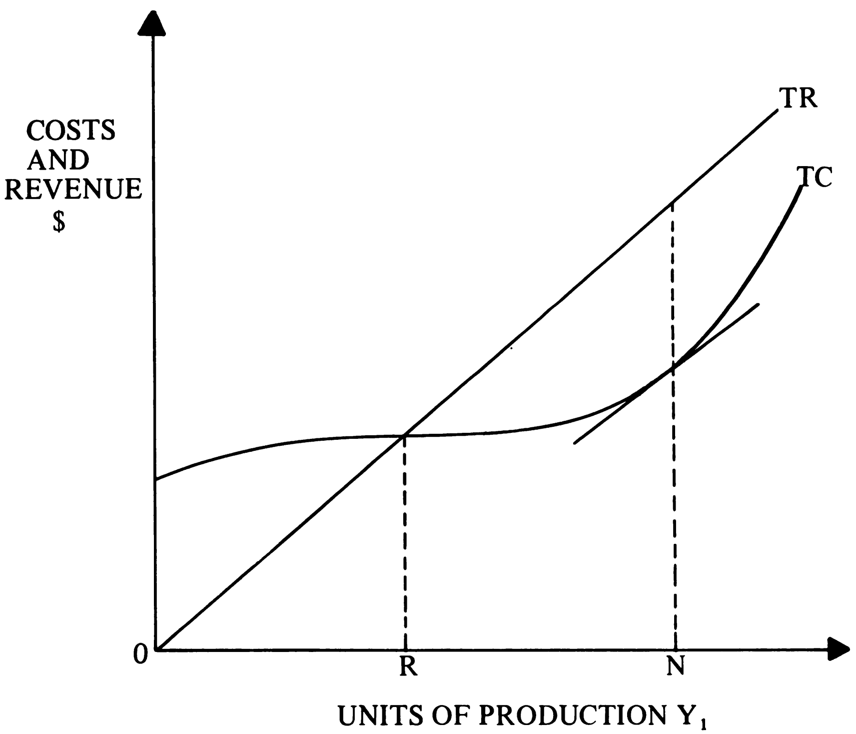

Fig. 16. Ratios of total cost and total revenue to production.

The necessary conditions for "maximizing" income can be expressed in terms of marginal revenue and marginal cost.

If total revenue can be defined by multiplying the total product by its price, then:

$$TR = Y_1 \; . \; P_{Y_1}$$

and:

$$AR = \frac{TR}{Y_1} = \frac{Y_1 \; . P_{Y_1}}{Y_1} = P_{Y_1}$$

where AR = average revenue
so that: $AR = P_{Y_1}$
or: average revenue = price of the product.

If marginal revenue is defined as the increase in revenue divided by the increase in output, then:

$$MR = \frac{\Delta TR}{\Delta Y} = \text{slope} = \text{price of the product at any point on the straight line*}$$

then: marginal revenue = price of product = average revenue
or: $MR = P_Y = AR$

Since marginal cost equals the slope of the TC curve and marginal revenue equals the slope of the TR curve, income reaches a maximum when $MC = MR = P_Y$ so that: marginal cost = marginal revenue = price of product.

Maximizing income: curves for cost per unit of production

Income maximization is generally analyzed in terms of the curve for cost per unit of production and the marginal revenue curve. It is basically the same analysis as that discussed above. Short-run cost curves appear in Figure 17. As has been pointed out, $MR = P_Y$; that is, the marginal revenue curve (MR) coincides with the demand curve, or lines P_{Y_1}, P_{Y_2}, and P_{Y_3} of Figure 17.

This line shows that various quantities of product have the same price. Income is maximized, in terms of total revenue, when the marginal cost (MC) is equal to the marginal revenue (MR), or where the two curves intersect.

(*) $TR = Y_1 \; . \; P_{Y_1}$ so that the slope of $TR = \frac{\Delta TR}{\Delta Y_1} = \frac{\partial (Y_1 \; . \; P_{Y_1})}{\partial Y_1} = P_{Y_1}$

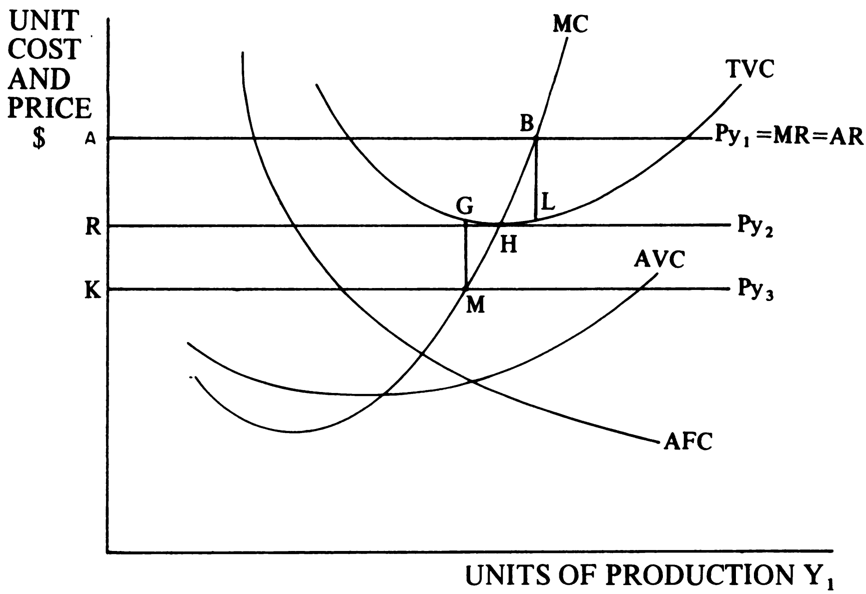

Fig. 17. Income maximization with unit cost curves per unit of production.

From this analysis it can be concluded that three conditions are required to maximize net income:

– The MC should be equal to the price of the product;

– The MC should be increasing; otherwise the producer is operating under conditions of maximum loss. Even if these two conditions are fulfilled, it does not mean that net income is or should be positive.

– Total revenue should be greater than total variable costs; that is, P_Y should be greater than the average variable cost if net income is to be positive. The portion of the MC curve above the AVC curve is the supply curve, or the volume of products that the enterprise can introduce into the market at different price levels.

This analysis can be more easily understood with the use of Figure 17, which gives the total variable, average variable, average fixed and marginal cost curves (Stigler[10]).

At price P_{Y_1} the firm will produce AB and will earn a profit of BL per unit. At price P_{Y_2} the firm will produce RH with no profit. At price P_{Y_3} the firm will produce KM and will incur losses of MG per unit; but if the firm decides not to produce at this price, its losses will be equal to its fixed costs.

In summary, the competitive firm will not produce at a price less than its average variable costs, since it would be more economical simply to stop all production.

Effects of price changes

If the price of an input or a product changes, it is logical to expect changes in the optimum level of production. A decrease in product price triggers a fall in the price line. As a consequence, marginal revenue drops off.

Production shifts caused by changes in input prices are the reverse of shifts caused by changes in product prices. Consequently, an increase in the price of a variable input pushes the cost curve upward. The MC and the P_{Y_1} intersect at a lower product level, and production must fall to maximize net income. If, on the other hand, input prices decrease, the cost of producing any level of product drops and the optimum level of production rises.

It should be emphasized again that the fact that MC = P_{Y_1} does not necessarily mean producer income is positive.

SUBSTITUTION PRINCIPLES, OR THE FACTOR – FACTOR RELATIONSHIP*

The input-output relationships were analyzed above, and the method for obtaining optimum production per unit of resource and product, or maximizing income, was discussed. The analysis was based on a simple function with only one variable factor. The continuous function in the example was $Y = f(X_1/X_2, X_3, \ldots X_n)$ with X_1 as the only variable factor.

In this section, we will answer the question of what is the most economical combination of resources that should be used to produce a given quantity of output. The production function becomes $Y = f(X_1, X_2/X_3, X_4, \ldots, X_n)$, where X_1 and X_2 are variable factors or inputs and $X_3, X_4, \ldots X_n$ are constant. It is assumed that the changes in X_1 and X_2 are not proportional.

Additionally, the changes in output Y will be examined as one or both factors X_1 and X_2 vary. The possibilities of substituting X_1 for X_2 when Y is maintained constant at a particular level will also be examined.

(*) This section is based on guidelines by Dillon[2].

The input-input ratio, or the resource substitution ratio, can be analyzed for productive units of any size; fixed factors can vary in both quantity and number.

If we take livestock production as the technical unit, buildings and services become fixed resources, and protein and carbohydrate feeds, forage and grains are the variables. Similarly, a hectare of land can be considered a technical unit, or a fixed factor, while irrigation and fertilizer can be substitutable. The replacement of labor by machinery is another type of relationship that can be studied if the technical unit is a farm or the area of a project. This substitution analysis can also be applied to regional agriculture and to the agricultural industry.

The production process for the majority of goods makes it possible to obtain the same product by using various combinations of inputs. For this reason the producer can reduce costs only by changing the combination of inputs.

The analysis of substituting a factor X_1 with another factor X_2 provides two basic figures:

– maximum output for given factor costs; and

– a certain level of production using a minimum of factors.

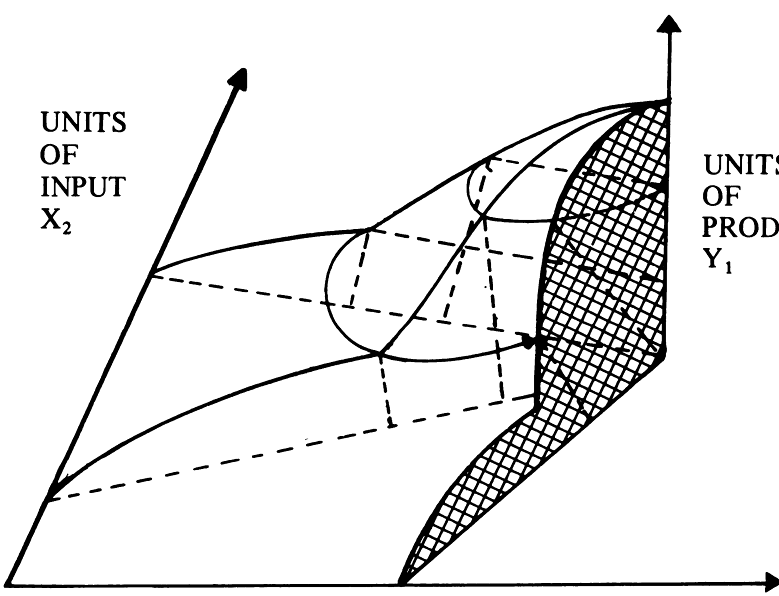

Fig. 18. The production function with two variable inputs (X_1, X_2) where Y_1 is the product.

Income can be maximized by combining variable factors or resources at a minimum cost.

GRAPHIC REPRESENTATION OF THE FUNCTION

In contrast to the case of one variable factor, represented by a single curve, the input-input relationship is three dimensional, and the three axes are X_1, X_2, and Y. The two ways of plotting this function are the three-dimensional surface (see Figure 18) and the series of concave lines in two dimensions (see Figure 19). The latter method is more widely used in economics texts, because it lends itself to a clearer analysis.

Curves Y_1, Y_2 and Y_3 of Figure 19 are called **isoquants** or **isoproducts**. They represent all those combinations of the two factors X_1 and X_2 with which a firm can obtain equal amounts of output.

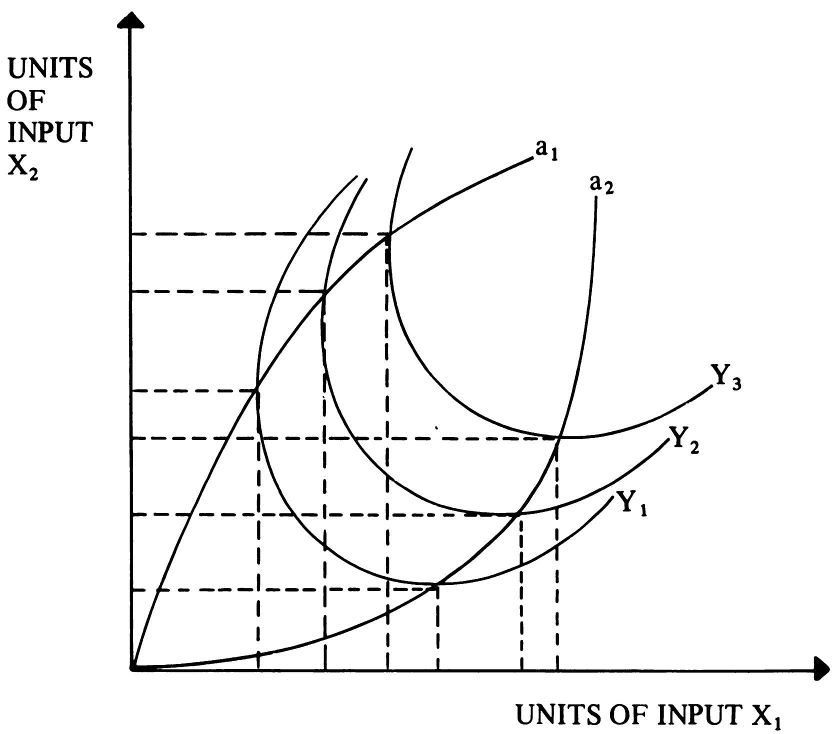

Fig. 19. Production function with two variable factors X_1 (forage) and X_2 (concentrates)for producing milk, Y.

The slope of the isoproduct line is the marginal rate of substitution (MRS) between the factors; that is, it tells us to what extent one factor can be replaced by another if production is to remain constant. It is the point at which the MRS of X_1 and X_2 is equal to

$$\frac{\Delta X_2}{\Delta X_1}.$$

Figure 19, besides giving the isoproduct curves, includes uninterrupted lines called **isoclines** (a_1 and a_2). These lines connect the isoproduct lines Y_1, Y_2, and Y_3 at the points of equal marginal rates of substitution. The equation of the isocline for a specific marginal rate of substitution K can be obtained by solving the equation

$$K = \frac{\partial X_2}{\partial X_1}$$

The isoclines for K equal to zero or infinity are the outer limits for rational combinations of inputs (that is, stage II of the production function with one variable input). For any combination of inputs which falls outside these border lines, a lower level of production can be obtained with a lower combination of inputs (Dillon[2]).

COMBINATION OF INPUTS OR FACTORS

Factors or inputs can be combined in three ways:

Fixed proportions

Factors are combined in fixed proportions to produce a product. For example, water (H_2O) requires two molecules of hydrogen and one of oxygen. In the case of agriculture, the tractor-driver combination would be one example (see Figure 20).

Constant rate of substitution

Factors are interchangeable at a constant rate, regardless of the quantity of factors used to obtain a given level of production. An example is the combination of oats and barley used for certain kinds of livestock (see Figure 21).

Variable rate of substitution

This is illustrated in Figure 22, where the marginal rate of substitution varies along the product curve. The quantity of X_2 needed to compensate for the loss of a given quantity of X_1, still maintaining

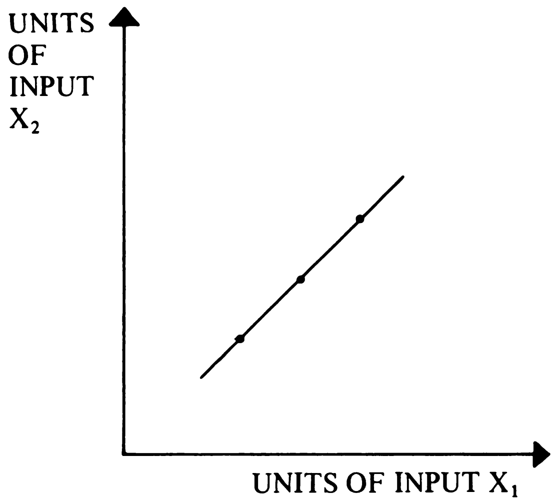

Fig. 20. Combination of inputs in fixed proportions.

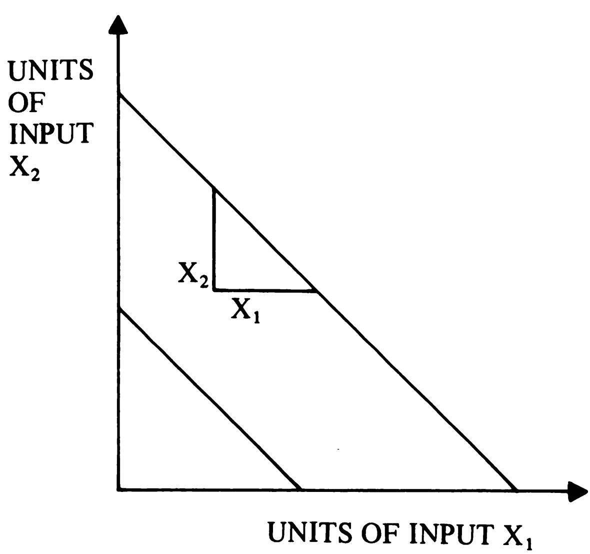

Fig. 21. Inputs with constant marginal rate of substitution.

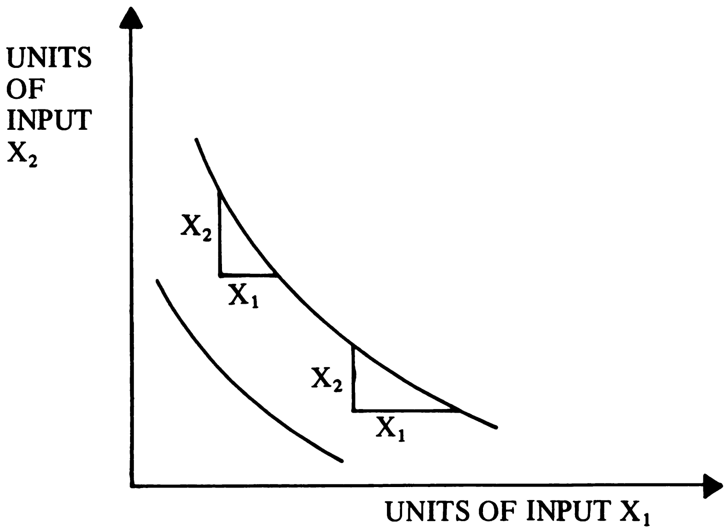

Fig. 22. **Inputs with variable marginal rate of substitution.**

the same level of production, increases as the quantity of X_1 decreases, since $\Delta X_2/\Delta X_1$ is greater than $\Delta X_2'/\Delta X_1'$. Hay and grain are examples of factors with a variable rate of substitution.

OPTIMUM COMBINATION OF INPUTS OR RESOURCES

The isocost line in Figure 23 shows the various combinations of resources the firm can purchase, given its budget and the unit price of each factor or resource.

If we assume that the firm uses only two resources, X_1 and X_2, the respective prices will be P_{X_1} and P_{X_2}. The equation of the isocost line is $P_{X_1} \cdot X_1 + P_{X_2} \cdot X_2 = M$, where M is the available budget for acquiring X_1 at price P_{X_1}, plus X_2 at price P_{X_2}. If the firm uses only resource X_1, it can buy M/P_{X_1} units of X_1, while if it uses only resource X_2, it can buy only M/P_{X_2} units of X_2. The straight line joining these two points gives the combination of X_1 and X_2 that the firm can buy with budget M, and it is called the isocost line. The slope of the isocost line is:

$$\frac{M/P_{X_2}}{M/P_{X_1}} = \frac{M}{P_{X_2}} \times \frac{P_{X_1}}{M} = \frac{P_{X_1}}{P_{X_2}}$$

The optimum combination of resources, given their unit price, appears graphically at the point where the slope of the isocost line (equal costs) is equal to the slope of the isoproduct curve (point R in Figure 23), or where

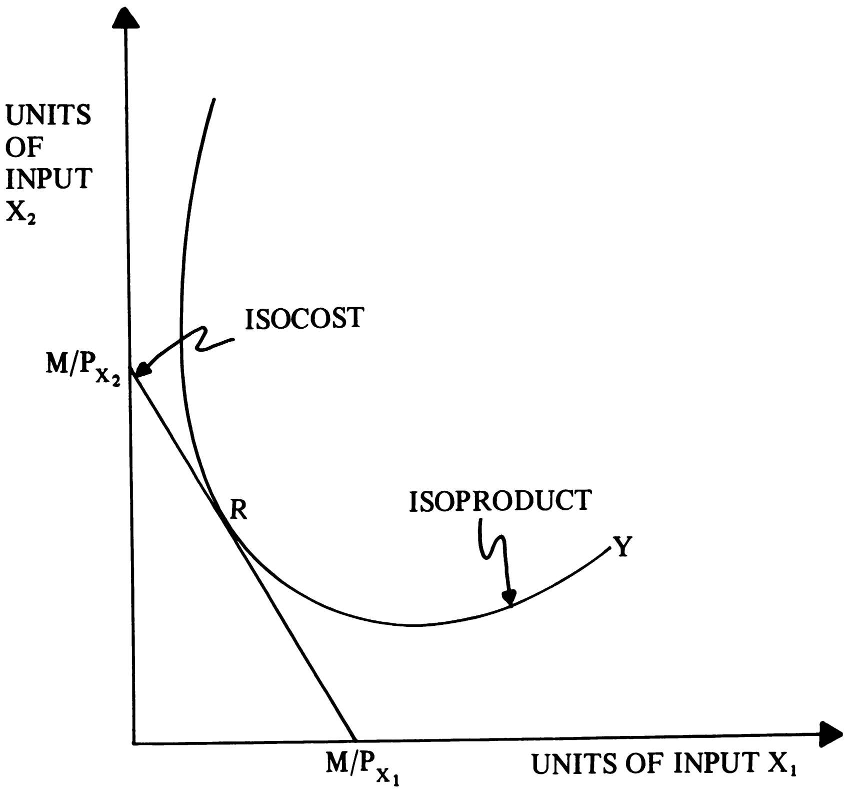

Fig. 23. Minimum cost combination of two resources X_1 and X_2 for given P_{X_1} and P_{X_2} for level of production Y.

$$\frac{P_{X_1}}{P_{X_2}} = \frac{\Delta X_2}{\Delta X_1}, \text{ so that } P_{X_1} \cdot \Delta X_1 = P_{X_2} \cdot \Delta X_2$$

Therefore, the condition necessary for obtaining the optimum combination of two resources for a given level of production is achieved when the marginal rate of substitution $\frac{\Delta X_2}{\Delta X_1}$ is equal to the inverse ratio of the resource prices, so that

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

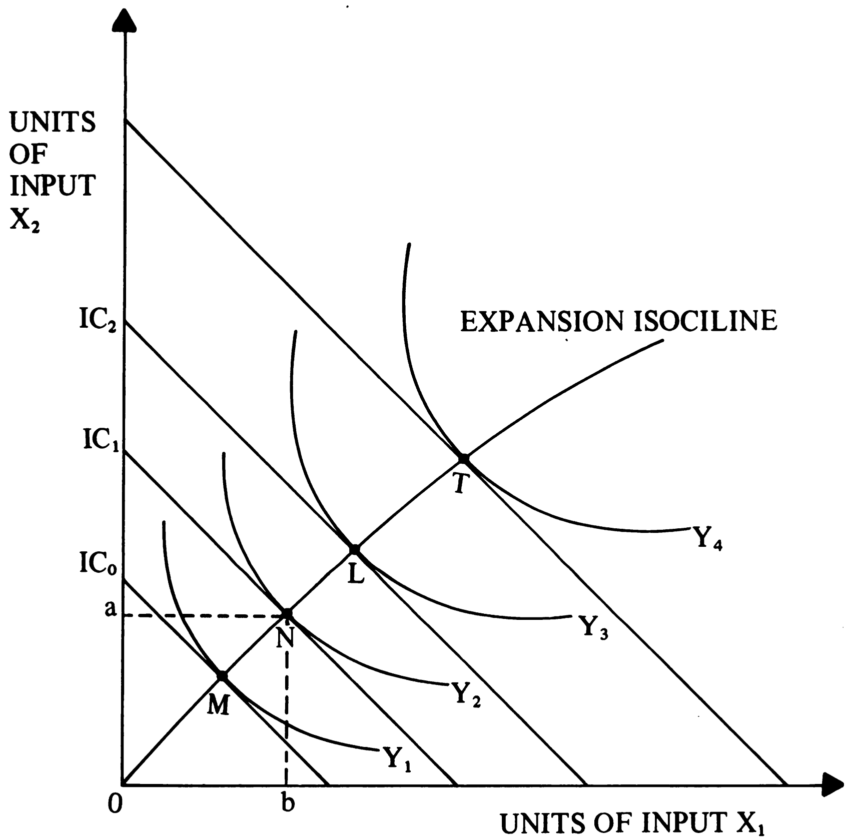

Fig. 24. Hypothetical production function with two variable resources, X_1 and X_2, showing line of minimum cost combinations of these resources.

Derivation of the formula

If the price of the input and the value of the marginal product are known, the optimum input level can be determined when $MPV_{X_1} = P_{X_1}$, or the marginal product value is equal to the factor price. According to Vincent[11], for two factors or resources, the equation would be:

$$MPV_{X_1} = P_{X_1} \text{ and } MPV_{X_2} = P_{X_2} \quad [1]$$

If these equations are divided by their prices, we have:

$$\frac{MPV_{X_1}}{P_{X_1}} = 1 \quad \text{and} \quad \frac{MPV_{X_2}}{P_{X_2}} = 1 \quad [2]$$

Since both equations are equal to one, we find:

$$\frac{MPV_{X_1}}{P_{X_1}} = \frac{MPV_{X_2}}{P_{X_2}} = 1 \qquad [3]$$

That is, the equations indicate the best level of production and the resource combination. Thus, for any level of production:

$$\frac{MPV_{X_1}}{P_{X_1}} = \frac{MPV_{X_2}}{P_{X_2}} \qquad [4]$$

This equation can be written in another way since the marginal product value is equal to the marginal product multiplied by its price, or

$MPV_{X_1} = MP_{X_1} \cdot P_Y$, thus:

$$\frac{MP_{X_1} \cdot P_Y}{P_{X_1}} = \frac{MP_{X_2} \cdot P_Y}{P_{X_2}} \qquad [5]$$

Dividing both sides of the equation by P_Y gives:

$$\frac{MP_{X_1}}{P_{X_1}} = \frac{MP_{X_2}}{P_{X_2}} \qquad [6]$$

Since marginal product is equal to the change in output obtained by altering one factor, or $\frac{\Delta Y}{\Delta X}$, the equation can be written:

$$\frac{1}{P_{X_1}} \quad \frac{\Delta Y}{\Delta X_1} = \frac{1}{P_{X_2}} \quad \frac{\Delta Y}{\Delta X_2} \qquad [7]$$

For this analysis it can be assumed that both ΔY's are equal and that dividing both sides of the equation by ΔY will give:

$$\frac{1}{P_{X_1} \Delta X_1} = \frac{1}{P_{X_2} \Delta X_2} \text{ or } P_{X_1} \Delta X_1 = P_{X_2} \Delta X_2 \qquad [8]$$

Dividing both sides of equation [8] by $P_{X_2} \Delta X_1$ gives:

$$\frac{P_{X_1} \Delta X_1}{P_{X_2} \Delta X_1} = \frac{P_{X_2} \Delta X_2}{P_{X_2} \Delta X_1} \qquad [9]$$

which, simplified, is:

$$\frac{\Delta X_2}{\Delta X_1} = \frac{P_{X_1}}{P_{X_2}} \qquad [10]$$

Therefore, the necessary condition for achieving the optimum combination of resources for a given level of production occurs when the marginal rate of substitution $\frac{\Delta X_2}{\Delta X_1}$ is equal to the inverse ratio of the input prices.

PRODUCTION EXPANSION LINE

The optimum point of production with two resources can be determined with the use of the input-input model described above. This point is located on the isocline of expansion, or the line connecting the points of tangency between the isocost lines and the isoproduct curves (see Figure 24 M,N,L,T) (Rodríguez Alcaide[9]).

The problem faced by any firm with a set budget is to operate at the highest possible level of production permitted by these cost restrictions. That is, it must find the highest isoproduct curve the budget will allow. In Figure 24, the highest level of production possible with budget IC (isocost) occurs at point N on Y_2. The firm uses amount a of X_2 and amount b of X_1 and will produce at level Y_2. With any other combination of X_1 and X_2 that can be obtained with budget IC_1, the firm will need to move upward or downward from the isocost line to a greater or lesser isoproduct curve. For this reason, the combination of a of X_2 and b of X_1 is the lowest cost alternative for producing Y_2. At N, the cost IC_1 is the lowest possible cost for obtaining Y_2. Figure 24 shows that if some other combination of resources is used to produce Y_3, the cost will be greater, for the operation will take place on another isocost line further to the right (for example, IC_2).

Given the prices of X_1 and X_2 and the firm's budget, any changes in prices will shift the isocost line toward another parallel curve. If, for example, the line were IC_O, below IC_1, the line would shift to the left. Point M on line IC_O is the lowest possible cost for producing Y_1. In the same way, the isocost curve IC_2 represents a higher cost and would shift the curve to the right of IC_1. Point L indicates the lowest possible cost for producing Y_3. Line M,N,L,T, connecting the lowest cost points for each combination of resources for isoproducts Y_1, Y_2, Y_3 and Y_4, is called the firm expansion line. It represents the most efficient means of producing each volume of production, given the relative factor prices.

PRODUCT-PRODUCT RELATIONSHIP*

The product-product relationship facilitates decision-making on the degree of specialization or diversification desired for the farm or project area. It answers the question as to what products should receive given quantities of productive resources.

This analysis is based on the same assumptions of perfect competition. In addition, we further simplify the analysis by assuming that a limited quantity of resource X_1 can produce only two products, A and B. The functions will be:

$$A = f(X_1/X_2, X_3, \ldots, X_n)$$

$$B = f(X_1/X_2, X_3, \ldots, X_n)$$

$$X_1 = f(A,B)$$

Therefore, two production possibilities curves can be plotted with limited quantities of X_1 (see Figures 25 and 26).

The possible combinations of production of A and B, with a fixed quantity of resource X_1 available, can be represented graphically. In Figure 27 at point a, it is assumed that all units of X_1 are employed to produce A, and it is thus impossible to produce B; at point **b**, it is assumed that all units of X_1 are used to produce B, and no A can be produced. Any point on the curve connnecting these two points, for example c, indicates the quantity of B which must be sacrificed in order to produce a given quantity of A. This relationship is called the marginal rate of substitution of A for B, or:

$$\frac{\Delta A}{\Delta B} \quad \text{or} \quad \frac{\Delta B}{\Delta A}$$

This rate gives the degree to which two products can be substituted for each other in the production process, given a limited quantity of resources.

(*) This section follows the guidelines of Bishop and Toussaint[1] and Heady[3].

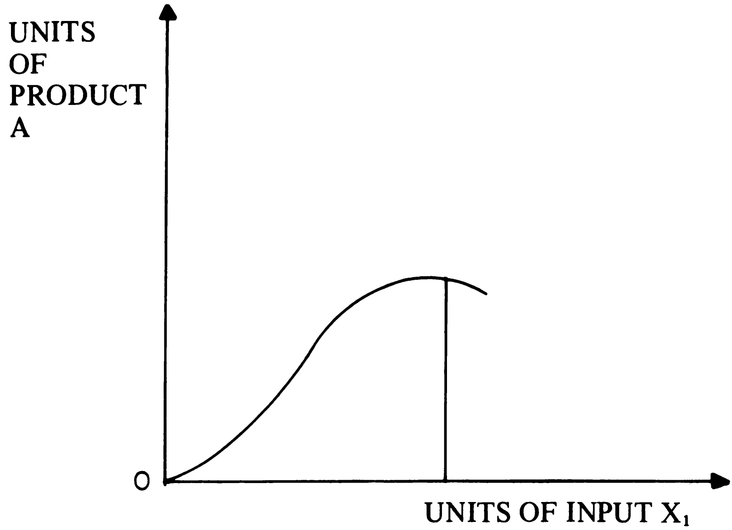

Fig. 25. Production possibilities curve with limited X_1.

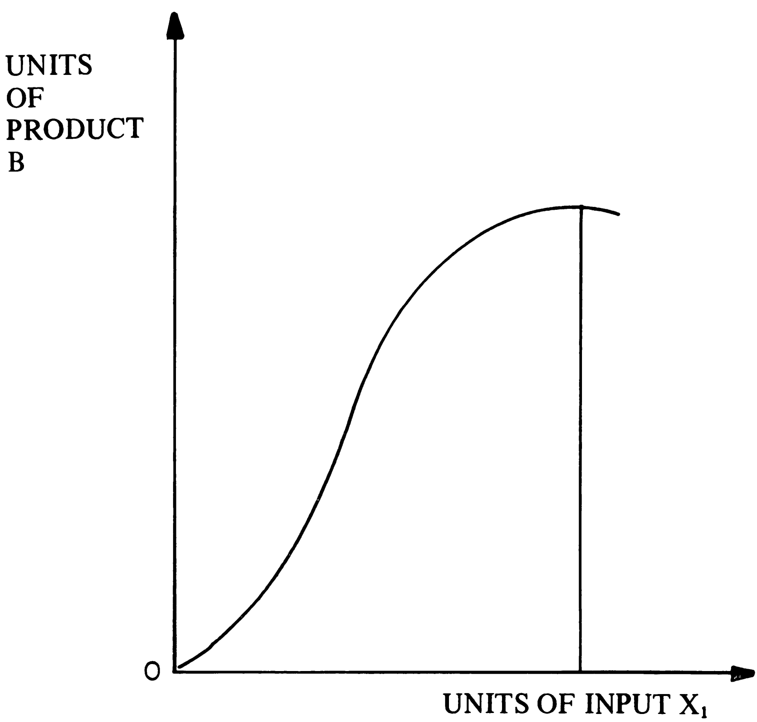

Fig. 26. Production possibilities curve with limited X_1.

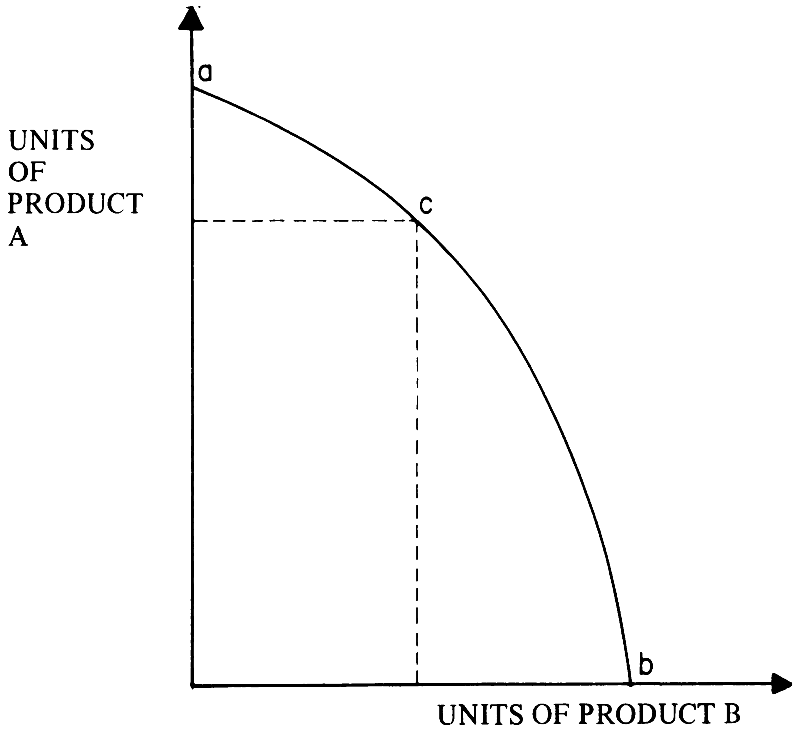

Fig. 27. Production possibilities curve for competitive products.

Production possibilities curves

Various types of production possibilities curves are possible, and each has its own economic implications.

COMPETITIVE PRODUCTS are those for which, given a certain level of resources, an increase in the production of one product causes a reduction in the production of the other. The products replace each other. If the marginal rate of substitution is less than zero, the products are competitive and production of one must be sacrificed for the production of the other.

$$\frac{\Delta A}{\Delta B} \quad \text{or} \quad \frac{\Delta B}{\Delta A} < 0 \qquad \text{(competitive)}$$

COMPLEMENTARY PRODUCTS are those for which production can be increased by transferring resources from one product to another. Thus, if the marginal rate of substitution is greater than zero, the products are complementary.

$$\frac{\Delta A}{\Delta B} \quad \text{or} \quad \frac{\Delta B}{\Delta A} > 0 \qquad \text{(complementary)}$$

SUPPLEMENTARY PRODUCTS are both produced with the same resource, but it is possible to increase the production of one by increasing use of the resource, without affecting the rate of production of the other. Thus, if the marginal rate of substitution is equal to zero, the products are supplementary.

$$\frac{\Delta A}{\Delta B} \quad \text{or} \quad \frac{\Delta B}{\Delta A} = 0 \qquad \text{(supplementary)}$$

In practice, such a case generally occurs with two crops that use the same machinery or labor, but during different time periods.

The above relationships are illustrated in Figures 28 and 29.

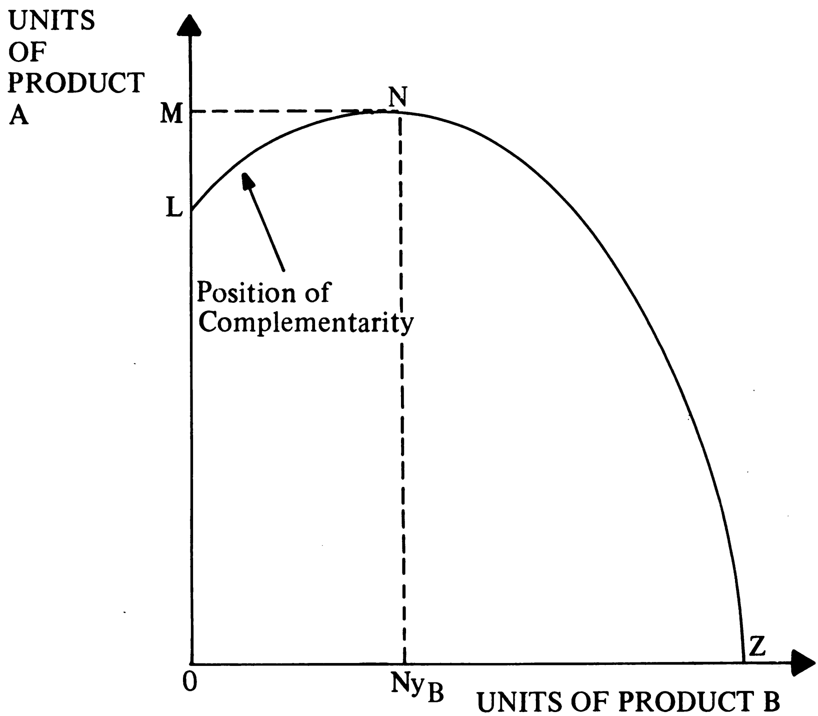

Fig. 28. Production possibilities curve for two complementary products.

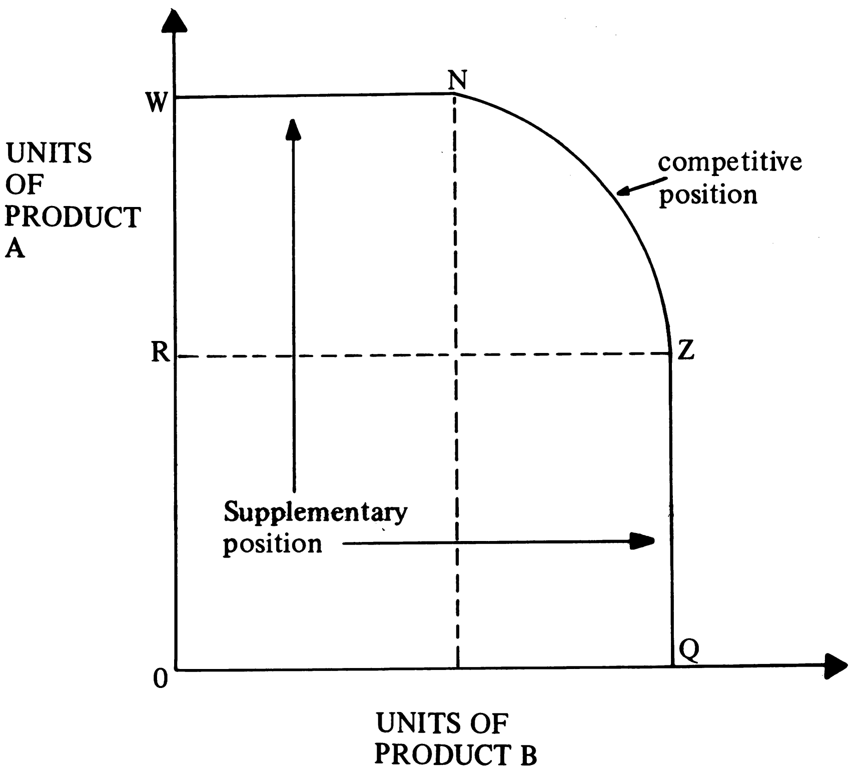

Fig. 29. Production possibilities curve for two supplementary products.

In Figure 28, products A and B are complementary between the area L and N, since both increase as resources are transferred from one product to the other. This occurs when a legume is rotated with corn. Between points N and Z, they are competitive, because an increase in A means that production of B must be sacrificed, and vice versa.

In Figure 29, product B can be increased between W and N without affecting production of A. Similarly, product A can be increased between Q and Z without affecting production of B. Thus, A and B are supplementary between W and N and Q and Z.

Optimum product combination

If we assume that the rational producer will operate within the range where products are competitive, the optimum production level in the competitive stage depends on the marginal rate of substitution and the price ratio. The former tells us the rate at which the products can be substituted for each other in production, and the latter shows how the products can be exchanged in the market.

The line of equal revenue, or the isorevenue line, gives the various product combinations that can yield the same revenue at a given unit price for the products (line RL in Figure 30). The slope of this line is the ratio between the per-unit product prices (P_A and P_B).

The maximum net income which can be obtained from a given quantity of resources is achieved when the marginal rate of substitution between two products is equal to the rate at which the products can be exchanged for each other in the market.

That is: $\dfrac{\Delta A}{\Delta B} = \dfrac{P_B}{P_A}$

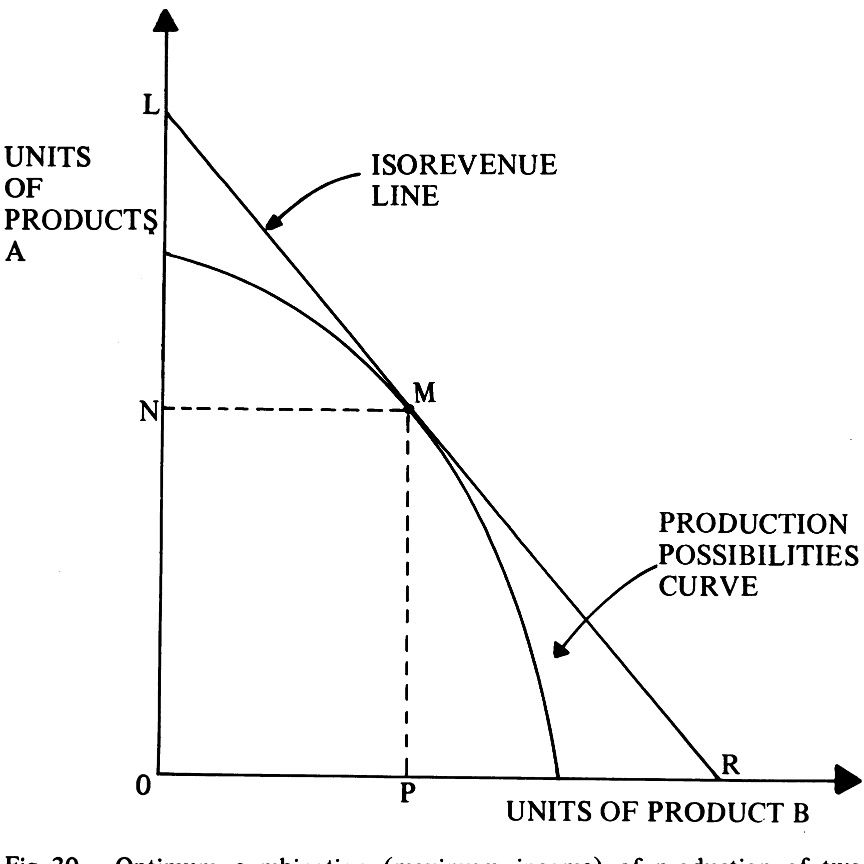

Fig. 30. Optimum combination (maximum income) of production of two products A and B.

In transferring factors from B to A, if $P_A \cdot \Delta A > P_B \cdot \Delta B$, more factors should be put into the production of A, and B should be reduced. On the other hand, if $P_A \cdot \Delta A < P_B \cdot \Delta B$, it is more profitable to pour factors into the production of B.

PRINCIPLE OF COMPARATIVE ADVANTAGE

Under the basic conditions of perfect competition, it is assumed that all buyers and sellers have perfect mobility and are either present in the marketplace or can be brought there without cost. This assumption has a theoretical use but is not valid under real conditions. Land resources are located at variable distances from centers of economic activity and imply the costs of transporting products from the farm to the market and bringing capital, services and inputs to the farm. For this reason, the location of the farm becomes an economic problem (Bishop and Toussaint[1]).

The introduction of technology increases ability to produce goods and services with a given quantity of productive resources. An increase in efficiency leads to greater specialization. Likewise, frequent changes in the degree of specialization make the adoption of new technologies possible, and efficiency is further improved. Higher levels of specialization increase the level of production and exchange or the means by which people obtain goods and services produced by others in exchange for their own. Specialization occurs both on the individual level and within geographic areas, and therefore we often speak of interregional exchange. Regions are areas of various sizes with homogeneous characteristics in terms of certain selected resources: climate, soils, topography and type of agriculture.

Inter-farm relationships, as discussed previously, make it easy to understand why regions or farms specialize in the production of certain products. Wherever products are competitive and the marginal rate of substitution is constant, specialization occurs.

On the other hand, specialization is lower for competitive products with a rising marginal rate of substitution. When the possibility of introducing complementary and/or supplementary products is higher, there is a greater tendency for diversification.

Many factors act together to determine the types of agriculture used in a country, region or even at the farm level. These factors include land characteristics such as soil texture, fertility, humus content, salinity, phreatic level, topography; natural conditions of the region, such as precipitation, temperature, length of daylight, winds, presence of diseases and insects, length of the growing season, ease and cost of transportation and marketing; social aspects such as quantity and type of available labor, traditions and local customs, and educational levels of the farmers.

Farm management literature has generally used the principle of comparative advantage to explain why a zone or region specializes in the production of a specific product. It also explains the principles of location of agriculture, such as why a certain zone is dedicated to producing fruit, sugar cane or livestock.

Some authors define the principle as follows: a product tends to be produced whenever the ratio or proportion of its advantages is greater than that of other products, or when the ratio of disadvantages is less.

The principle establishes that, in view of their different requirements, various crops and livestock should be developed in the particular areas, regions or farms where the physical, natural, economic, social and cultural resources are most favorable for production or reproduction. These factors should be taken into account when decisions are made on the location of a project.

Any country, region or farm may also have absolute advantages over another country, region, area or farm due to differences in the adaptation and requirements of the crops themselves, as well as the differences in physical, natural, economic, social, and cultural conditions.

Both the planner and the farmer must have a full understanding of these conditions before deciding which crops to plant or which breed of cattle to raise.

Any country, region or farm can either enhance or lose its comparative advantage. Factors acting to shift comparative advantage include:

- The adoption of new crop techniques, such as the use of improved seed or a complete fertilizer.

- Changes in market demand and/or prices of products or inputs.

- Reduced shipping costs due to road improvement, better transportation systems or other factors.

- Land improvement through irrigation or drainage.

- Changes in social and cultural conditions and farmer expectations. For example, changes in land tenure systems and in the level of education of the population can shift the comparative advantage, especially when they act as limiting factors.

- Economies of scale, both internal and external, can be another source of comparative advantage. Suppose a certain area has a few large, efficient firms processing a given product, while another area has many small, inefficient enterprises. With a given quantity of resources, the large firms can surpass the small and win a comparative advantage for the product. This would be an example of an internal economy of scale. The following are methods of obtaining external economies: 1) transfer costs can be reduced by improving facilities for purchase and sale; 2) suppliers can operate nearby, thus reducing the cost of supplies; 3) other industries can be established in the area to use the by-products which otherwise would be wasted or only partially exploited; and 4) other economies may evolve from these three.

From the researcher's of point of view, the problem of location merits careful study. If it is the determining factor of relative advantage of a region or farm, the problem becomes relatively simple. The answer can be found by calculating the relative margin of net income per unit of land or head of stock for the entire set of crops or animals on the farm.

Net income per hectare of land or for a given crop depends on the yield per hectare, the product price, and the costs of production. High yields and high prices, together with low costs, reflect a certain comparative advantage for a farm in comparison with other farms in the region.

THE VON THUNEN MODEL AND ITS EFFECTS

One of the first studies of the relationship between spatial location and the problems of land use was conducted by German economist Von H. Thunen.*

In brief, the principle states that products whose shipping costs are high, relative to the product value, will be produced closer to the center of consumption than those whose shipping costs are low. Consequently, milk is produced closer to the center of consumption than hogs, which in turn are closer than grains.

To illustrate the Von Thunen principle, suppose that 100 liters of milk can yield 10 kilograms of cream and 4 kilograms of butter. The price of 100 liters of milk at the center of consumption is 500 pesos, while 10 kilograms of cream cost 450 pesos and 4 kilograms of butter cost 250 pesos. Shipping charges are 0.20 cents per kilometer for 100 liters of milk, 0.02 cents per kilometer for 10 kilograms of cream and 0.004 cents per kilometer for 4 kilograms of butter. The value of each product falls as the distance from the center of consumption increases; milk drops more rapidly than cream, which

(*) Von Thunen's illustration of the concept of an isolated state was a single town or European village located in the center of a productive plain which was surrounded by a wild region isolating it from other markets.

in turn decreases more rapidly than butter. At a certain distance, milk and cream have the same price. Where does this point occur? It can be determined with the following formula (Vincent[11]):

$$P_1 - R_1 \, . \, D = P_2 - R_2 \, . \, D, \text{ where}$$

P_1 = price of milk at the center of consumption;

P_2 = price of cream at the center of consumption;

R_1 = shipping rate for milk;

R_2 = shipping rate for cream;

D = distance

Replacing unknowns with values:

$$500 - 0.20\,D = 450 - 0.02\,D$$

$$500 - 450 = 0.20\,D - 0.02\,D$$

$$50 = 0.18\,D$$

$$D = \frac{50}{0.18} = 278 \text{ kilometers}$$

At a distance of 278 kilometers from the center of consumption, 100 liters of milk will have the same value as 10 kilograms of cream.

Graphically, this principle can be illustrated as a series of concentric rings radiating out from the center of consumption (see Figure 31).

The principle illustrates the effects that shipping facilities and distances from farm to market have on methods of land use.

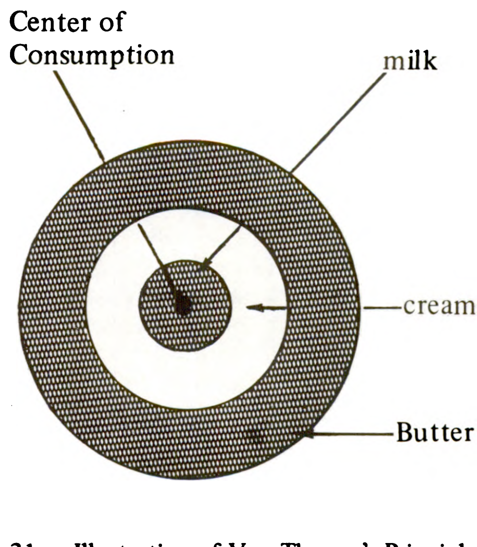

Fig. 31. Illustration of Von Thunen's Principle.

This principle is important in choosing the locations for production, processing and marketing of all agricultural products. Many of the problems of Von Thunen's day have been simplified with the appearance of railroads, but according to Ely and Wehrwein[3], the principle remains valid today, and some of its elements continue to be significant. As they observe, no matter what is done to perfect transportation, it will never be instant, effortless, or cost-free. The cost of overcoming friction, gravity and time loss while moving goods and people will never disappear. Farmers close to a city will always enjoy more advantages than those located far from the market, though they produce the same crops and have the same shipping facilities. The distance over which people can be moved comfortably is still a question of time, convenience and cost, often compounded by the congestion of modern transportation.

The effects of natural resources contribute to the location of production; but these effects only partially explain why certain production areas are chosen for particular products. It is safe to say that if large cities were moved to currently unpopulated areas, great changes would take place in the types of agricultural areas in a country.

ACTUAL PRACTICE: REAL-LIFE COMPLEXITIES

Taken separately, the principles and concepts explained in the preceding paragraphs are perhaps common knowledge, but together they provide the economist with an approach to agricultural management which may be somewhat different from that of the man on the street.

One major difference is the concept of profit. The layman may feel that the farmer has a right to expect a reasonable net income in exchange for the use of sound technological practices in operating the farm. Nevertheless, the economist expects reasonable profit only when the economic operations have been adjusted to cost and revenue factors resulting from the sale of products. In addition, the economist is sharply aware of the problem of diminishing returns that characterizes the input-output relationship in the use of variable resources.

If the use of such resources as fertilizers, feed, machinery and labor is subject to diminishing returns, theory suggests that every significant change in relative prices triggers a corresponding change in relative production using the various production factors. At times it is a very simple matter. If the price of fertilizer for potatoes increases, the potato farmer may make a satisfactory adjustment simply by ordering less fertilizer for the following year. But it frequently occurs that more drastic changes are involved. If milk producers in the Savanna of Bogota, for example, are faced with a price increase on commercial concentrates, their first reaction is to reduce the ration of feed per cow. But if the price change of the feed appears to be relatively permanent, the producers would begin to consider the possibility of planting more and better fodder, producing concentrates on their own farms, using fertilizer to increase feed production, or making other complementary changes in equipment and buildings. Thus, simple price shifts can lead to a drastic reorganization in which each change must be considered in terms of its overall effects on the entire business.

Economic theory analyzes such problems in terms of the physical quantities of each input or product, the prices of these items, and the revenues and expenditures recorded in the account books. This is the direct approach to the problem of combining the quantitative factor-product information provided by the scientist and the farmer with the price information produced by the economist for the purpose of analyzing possible alternatives for resource use.

The economist, in order to take part in this type of analysis, must understand the details of the production process involved in each case and be able to make maximum use of the knowledge contributed by scientist and farmer. Some may feel that economists should leave these matters to others and concentrate on monetary issues. Monetary values provide an extremely useful common denominator for measuring inputs and production in agricultural enterprises, but when the economist concentrates only on physical quantities, opportunities for analysis become severely restricted. The only alternatives available in such a case would be comparisons between farms. However, the conditions providing the basis for such a study would vary so widely that the validity of conclusions of the analysis would be highly doubtful, and not reliable enough to serve as a springboard for individual action.

Economists need not be concerned about overstepping their bounds when they explore the physical relationships which form the basis of all economic activity. They must learn to use other sciences that complement economics, and they must learn to consult specialists for help in areas in which they are not strong. They must learn to use, but not abuse, other disciplines.

The practical approach to the analysis of an agricultural enterprise is often so different from theory that it sometimes seems they are totally unrelated. Part of this stems from the difference between the complex aspects of the real situation and the simplified assumptions of the theory.

REAL-LIFE COMPLEXITIES

One of the most obvious differences is that farmers do not appear to strive for profit with the untiring vigor frequently attributed to the "economic man." In many cases the farmer appears to be completely satisfied to stick to accustomed paths, maintaining traditions and good technological practices, without showing much interest in extra income that could be earned here or there. But this in fact does not contradict theory, for the calculations of the rational entrepreneur include many non-monetary costs and benefits, and the supply curve may even be backward sloping, as in Figure 32.

In such situations, the analyst whose responsibility is to provide necessary assistance to the farmer can leave things as they are. If responsibilities are broader, it may be time to begin awakening the farmer's interest in greater income opportunities. Farmers will be more interested in changing their management practices if they are fully aware of the alternatives. While this imperfect knowledge factor should be taken into account in the real world, it is difficult to give it effective treatment in theory.

Another area in which theory tends to oversimplify is in the definition of variables. Business theory deals with a small number of variable inputs, each of which can vary continually or independently.

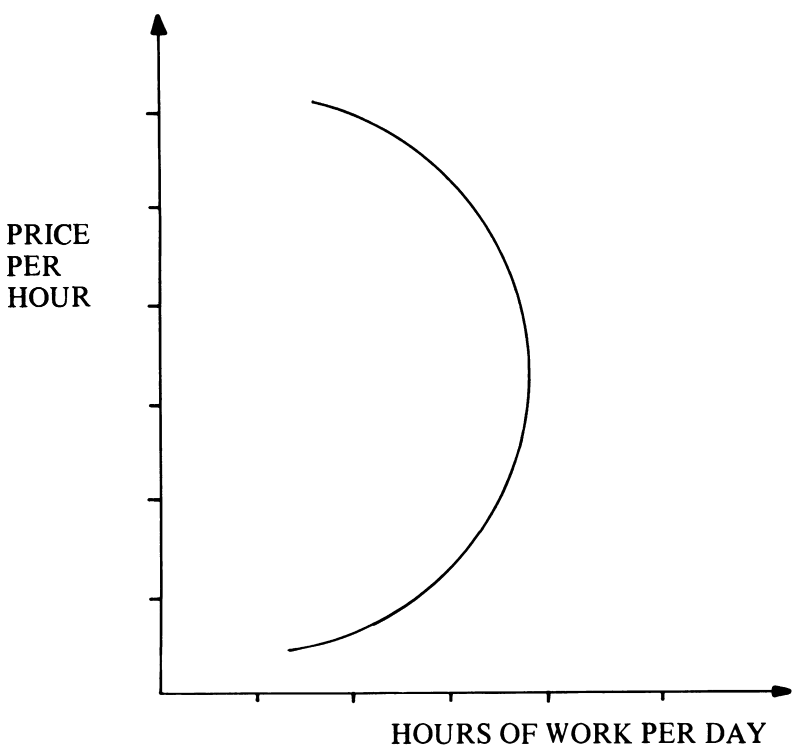

Fig. 32. Backward-sloping supply curve.

Generally, consideration is limited to a single product or a small number of products. By contrast, the farmer must generally deal with large numbers of inputs and products, especially if seasonal and quality variations are taken into account.

Farmers make their decisions in terms of the number of tractors, gallons of fuel and hours of driver time needed for the harvest. Inputs defined in these terms tend to be discontinuous, partially interrelated and difficult to manage from the theoretical point of view. Discontinuity could be reduced somewhat by grouping inputs into broad categories, such as "days of work" and "capital," but any analysis expressed in these terms will only lead to general and vague conclusions of doubtful validity.

Sometimes two or more complementary inputs can be combined into one single factor if they vary proportionally. This would be the case, for example, of gasoline consumption for a tractor and hours of labor for the driver. However, substantial increases in tractor operations could imply the need to use additional tractors which would consume gasoline at varying rates; these variables are thus interrelated, but discontinuously. Uncertainties and personal preferences also tend to be discontinuous. Agricultural management often has serious problems applying mathematical methods because the variables are neither continuous, linear, nor completely independent. These problems arise when production functions are adjusted to economic data and when attempts are made to use linear programming methods to analyze changes.

In view of all this, we find that the problem of determining our optimum point on the production function becomes much more complicated than the theoretical example of a mountain climber ascending steadily along a gradually curving surface to the point where additional efforts do not appear to be rewarded by extra gains. If the mountain climber analysis is to be of any use, it should be portrayed as an ascent up steep and broken terrain. At times it is necessary to jump from one point to another or occasionally descend a little in order to climb higher. Such terrain offers many intermediate vantage points, and the climber must decide whether to suspend the climb and stay on one of these points, or to challenge greater obstacles and move toward the summit. This being the case, the starting point for analysis is very important; a climber who already occupies a relatively favorable position may be ill-advised to descend temporarily in order eventually to rise higher. Rather, the same climber may be able to follow a gentle incline with a clearly marked trail and thus easily reach the higher level.

Among the obstacles lying in the path of the mountain climber —in this case a milk producer— are institutional barriers created by society, international restrictions or inspection standards which the milk producer must fulfill, and the physical characteristics of resources, products or production processes.

Other complications can arise, for the shape of the production functions is subject to constant changes due to large or small disturbances caused by technological progress and the gradual breakdown of the situation with the passage of time. In addition, just as new climbing ropes or new skill may affect the progress of the mountain climber, so new knowledge can bring about greater success for the entrepreneur.

The theoretical analysis assumes that business people automatically reach the highest level of production possible with the given quantity of resources in use.

In actual practice, the major benefit in farm management may be to increase the production achieved with a given level of resources, rather than to change the combination or quantity of resources used. This requires a greater knowledge on the part of the farmer and better use of existing technology. Economists may try to dodge these issues by claiming that they are strictly technical questions, but they are inseparable from the economic problems.

All these complexities of the real situation do not detract from the validity of the theory discussed above, but they make it more difficult to apply theories to practical problems. Finding the optimum position becomes a process of trial and error, rather than a task to be solved with mathematical precision. Nor can it easily be divided into separate parts, since each alternative for improvement should be evaluated in terms of its combined effects on the total outcome of the rural enterprise.

METHODS FOR CLASSIFYING FARM MANAGEMENT PROBLEMS

Although there is no satisfactory method of breaking down the field of farm management into groups of independent and separate problems, it would be helpful to comment briefly on various alternative classifications as a means of illustrating the scale of problems which must be considered.

Generally, the different means of classifying agricultural management problems tend to reflect the most important decisions the farm manager must take, such as:

– the choice and combination of crops or production lines;

– the total volume of the business and its components;

– the selection and combination of inputs;

– channels for product sales and input purchases;

– financing of agricultural business activities.

These decisions can be further broken down into a long list of secondary decisions. For example, when selecting a combination of products, the farmer must decide whether the business is going to be highly specialized or broadly diversified and, at the same time, select the individual crops. Decisions must also be made as to breeds of cattle and source of feed (home-grown or purchased), although the latter decision could also fall within the selection and combination of inputs. These decisions cannot be made without taking into account the size of the enterprise, the productivity of the soils, the quantity of available labor, the initial investments necessary for each new undertaking, and the availability of markets. It is much more than a simple question of determining the most profitable crop, since a combination of moderately profitable products may produce more favorable overall results.

Production economists could classify the majority of these decisions into three principal groups:

– product-product choice (proportions of products);

– factor-product choice (ratio of inputs and outputs); and

– factor-factor choice (proportions of inputs).

As has been stated, these types of decisions cannot be considered in isolation, because they are interrelated. In certain soils, wheat produces better results than potatoes if the level of fertilization is low; but potatoes produce better results than wheat if the use of fertilizers is increased. Sometimes milk production can be more profitable than crop production if the cows are fed properly and milk production per animal is high; but this may not be true if feed is inadequate.

It would be quite reasonable to assume that certain decisions carry more weight than others in the overall success of the farm, and that guidelines could be established for decision-making under given circumstances. On this basis, the following classification of agricultural management problems has been developed according to various factors which are considered of strategic importance for the success of the enterprise:

– size of the enterprise; under similar circumstances, greater profits can be expected from a larger operation than from a smaller one;

– high output per unit of land surface or per head of stock, since costs of production do not increase proportionally with yields;

– high yield per unit of labor, especially when labor is costly or relatively scarce;

- high yield per unit of machinery or equipment, as fixed production costs often rise without producing the additional output that would be necessary to adopt full mechanization;

- the careful selection of marketing methods; a slight difference in prices paid or received is often equal to the total profit margin;

- a careful equilibrium among all the key factors of success, since low yield or inefficient use of labor or machinery can easily turn net profit into loss.

By analyzing the results of the various crops in terms of the success factors described above, the farmer has often been able to obtain an idea of the magnitude and direction of new opportunities for boosting production. However, maximum efficiency in the use of one resource does not always lead to greater success of the enterprise as a whole, since efficiency is not independent of the volume of other inputs used. For example, high levels of production per unit of labor can be achieved if machinery, fertilizers and other inputs are adequate and are applied to land with a high production potential. Also, the increase in yield per unit of investment in machinery could be significant if almost all work had previously been done by hand. However, the ultimate success of any enterprise depends on the ratios between combined production of all products and combined use of all scarce resources.

Another system of classification, which has already been mentioned, is based on the principle that some factors are more easily controlled by the farmer than others. Individually, there is little the farmer can do to change the weather which affects his crops, the market price or the development of technical progress. These factors could be identified as "uncontrollables" in contrast with others, which are under the farmer's control, such as crop selection, machinery selection, planting dates or use rates of fertilizers, pesticides and herbicides.

This distinction between controllable and uncontrollable factors is, perhaps, insignificant or scarcely relevant, as the ability to adjust to uncontrollable factors may ultinately be just as important as the ability to control them. A farmer who cannot do much to control the weather can easily adjust crop selection and planting dates to expected weather conditions; farmers can irrigate to compensate for a lack of rainfall and can perhaps obtain insurance against unexpected risks. Although prices are out of their control, at least product selection can be adjusted, and the seasonal distribution of harvests and marketing methods can be fitted to expected situations.

Likewise, it would make little sense to classify under "controllable factors" the volume of business for farmers whose capital is extremely limited, or the selection of marketing channels for farmers who have no basis on which to predict price shifts in six alternative markets, all located nearby.

High price levels for agricultural products tend to bring higher profits for farmers than periods of low prices (assuming that the harvest is normal); when prices are down, sometimes the only way to improve profits may be to abandon agricultural activities in favor of some other type of occupation. Similarly, limited-resource farmers may not be able to earn a satisfactory living from farming activities. Cases have been seen, however, of limited-resource farmers who have managed to earn acceptable incomes even during times of unfavorable prices. This clearly shows that the farmer can in fact exercise partial, although not complete, control over his situation, even though there is no clear line between "controllable" and "uncontrollable" factors.

SUMMARY

Many farm management decisions are related to economic principles. One example is the law of diminishing returns, a technological principle describing a physical relationship between factors and products. It states that as successive units of one variable factor are added to fixed quantities of other factors, total production will rise, first at an increasing rate, then at a decreasing rate, finally reaching a point of absolute decline in production.

The necessary condition for maximizing income is:

$$\frac{\text{Factor price}}{\text{Product price}} = \text{Marginal Product}$$

or: $$\frac{P_X}{P_Y} = \frac{\Delta Y}{\Delta X} \quad (1) \text{ which is equal to } P_X \,.\, \Delta X = P_Y \,.\, \Delta Y \quad (2)$$

In other words the marginal product value is equal to the factor price (MPV = P_X).

If the factor price multiplied by its marginal product is less than the product price multiplied by its marginal product ($P_X \,.\, \Delta X < P_Y \,.\, \Delta Y$), greater quantities of the factor can be used profitably.

The term "cost" refers to the firm's disbursement or expenditure of funds. Economic theory distinguishes between short-run and long-run costs. The former is defined as a period of time too brief for the quantities of resources to be varied. The latter gives the producer time to vary the quantity of all resources employed per unit of time. All resources are variable.

The concepts of total and unit costs are also important in analyzing the firm's production. The former includes fixed costs incurred independently of volume of production in a given time period. Variable costs occur when variable factors are added to increase production per unit of time. Unit costs include average fixed costs obtained by dividing total fixed costs by total output at a given level of production. Average variable cost is obtained by dividing total variable costs by the corresponding level of production. Marginal cost is the increase in total cost necessary to increase production by one unit. Consequently, marginal cost is a direct function of variable costs.

An inverse ratio exists between average variable cost (AVC) and average physical product (APP) which is expressed as:

$$AVC = \frac{P_{X_1}}{APP}$$

The same occurs between marginal cost (MC) and marginal product (MPP):

$$MC = \frac{P_{X_1}}{MPP}$$

The level of maximum income can be determined by comparing total costs to total revenue; it is reached when marginal revenue is equal to the product price ($MR = P_Y$). In terms of unit costs, income maximization is obtained when marginal cost is equal to the product price ($MC = P_Y$).

The long-run average cost curve defines economies and diseconomies of scale. The descending segment of the curve is called increasing returns or economies of scale; decreasing returns or diseconomies of scale appear on that part of the curve in which average costs are rising.

Internal economies take place inside the firm and are achieved by size adjustments. External economies occur outside the production unit. Both can be grouped by source as either monetary (market) or technological.

Another important principle is factor or input substitution. The possibility of substituting one given factor (X_1) by another (X_2) is analyzed for two reasons:

1. to obtain maximum production for given factor costs, and

2. to maintain a certain level of production with minimum factor costs.

In order to achieve the optimum combination of two factors at a given level of production, the marginal rate of substitution $\frac{\Delta X_2}{\Delta X_1}$ must be equal to the inverse price ratio $\frac{P_{X_1}}{P_{X_2}}$

or:

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

The product-product relationship facilitates decisions on the degree of specialization or diversification within the firm, the region or the project area. The various types of relationships between products competing for the same factors are: competition, complementarity, and supplementarity. Producers take advantage of the complementary and supplementary relationships by increasing production to the point at which the relationship becomes competitive.

At a given level of input, the condition for income maximization is attained when $PA \cdot \Delta A = PB \cdot \Delta B$. This means that profit can no longer be increased by transferring resources from A to B, or vice versa.

The law of comparative advantage explains why a product tends to be produced in areas in which it has the greatest advantage or the least disadvantage in comparison with other products. This principle helps explain why specialization and diversification occur by enterprise, region, or even country.

Another set of considerations should be taken into account when the principles of economic theory are put into practice. They involve such matters as the general assumptions made for working out the analysis; the state of flux to which the operational variables are subject; institutional changes; and the level of uncertainty under which agricultural production must operate.

QUESTIONS AND EXERCISES

EXERCISE No. 1. FACTOR-PRODUCT RELATIONSHIPS

a. On the basis of the data in Table 3.1, calculate:

– average physical product;
– marginal physical product.

b. Draw the corresponding graphs for:

– total physical product;
– average physical product;

– marginal product;
– establish the relationships between three types of production by filling in the signs (greater than, equal to, or less than) in the following equalities or inequalities:

when MPP APP, APP is increasing;
when MPP APP, APP is decreasing;
when MPP APP, APP is at its highest point;

– indicate the three stages of production on the same graph;
– indicate the rational stage of production, and explain what it means;
– what data would be needed to determine the optimum level of input?

c. State, in your own words, the law of diminishing returns.

d. Briefly explain why the law of diminishing returns operates.

Table No. 3.1. Factor-product relationship – Hypothetical data.

Fixed factors (X_0)	Variable factor (X_1)	Total physical product (Y_1)	Average physical product (Y_1/X_1)*	Marginal physical product ($\Delta Y_1/\Delta X_1$)**
1	2	3	4	5
1	0	0		
1	1	7		
1	2	17		
1	3	31		
1	4	47		
1	5	57		
1	6	63		
1	7	65		
1	8	65		
1	9	61		
1	10	59		

(*) Column 3 / Column 2.

(**) Change in Column 3 / change in Column 2. Place the results in Column 5 between each pair of lines.

EXERCISE No. 2. DETERMINING THE OPTIMUM LEVEL OF A SINGLE VARIABLE FACTOR*

a. If product price (P_Y) is 2 monetary units, and factor price (P_{X_1}) is 4 monetary units, calculate the following figures and place them in the corresponding columns of Table 3.2:

- total revenue or $P_{Y_1} \cdot Y_1$ = 2 x column 2 of Table 3.2;
- average product value = $P_{Y_1} \cdot AP.$ = 2 x column 4 of Table 3.1.;
- marginal product value = $P_{Y_1} \cdot MP_{X_1}$ = 2 x column 5 of Table 3.1.;
- total cost or $P_{X_1} \cdot X_1$ = 4 x column 1 of Table 3.2.;
- Net Income (Total Revenue minus Total Costs) = column 3 minus column 6 of Table 3.2;

TABLE No. 3.2. Revenue, cost and net income functions

		$P_{Y_1} = 2$ m.u.			$P_{X_1} = 4$ m.u.		$P_{X_1} = 12$ m.u.	
INPUTS X_1	PRODUCTION Y_1	Total Revenue TR ($P_{Y_1} \cdot Y_1$)	Average Product Value APV ($P_{Y_1} \cdot$ AP)	Marginal Product Value MPV ($P_{Y_1} \cdot$ MP)	Total Cost TC ($P_{X_1} \cdot X_1$)	Net Income (TR-TC)	Total Cost TC ($P_{X_1} \cdot X_1$)	Net Income (TR-TC)
1	2	3	4	5	6	7	8	9
0	0							
1	7							
2	17							
3	31							
4	47							
5	57							
6	63							
7	65							
8	65							
9	61							
10	59							

(*) To simplify the calculations, only one variable factor is considered. Costs of shipping, handling, etc. are not included.

– How many units of fertilizer should be used to obtain the greatest net income? What is this point called?

b. If the price of X_1 changes to 12 monetary units, calculate the new costs and new net income. Remember that the price of Y_1 has not changed, so you should use the same column 3 figures to calculate the new net income.

– Where is the new optimum point located?
– Is profit greater or less? Explain why.

EXERCISE No. 3. COST AND INCOME FUNCTIONS

a. Complete the columns of Table 3.3. Assume the fixed cost is 20 monetary units, the cost of each unit of variable input is 5 monetary units, and the price of each kilogram of product is 2 monetary units.

b. Plot curves AFC, AVC, ATC and MC from the information in Table 3.3 and draw in marginal revenue, average revenue and product price. Find the rectangles that give total revenue, total cost and net income with their respective values. What is the optimum point of production or of maximum net income?

c. Establish the relationships between marginal cost, average cost and average variable cost.

Table No. 3.3. Costs and incomes calculated by units of production.

Variable inputs (X)	Total Production (Y_1)	Fixed Cost (FC)	Variable Cost (VC)	Total Cost (TC)	Average Fixed Cost (AFC)	Average Variable Cost (AVC)	Average Total Cost (ATC)	Marginal Cost (MC)
1	2	3	4	5	6	7	8	9
1	7							
2	17							
3	31							
4	47							
5	57							
6	63							
7	65							
8	65							
9	61							
10	52							

d. List the three conditions required for income maximization.

e. Briefly compare in graphic and descriptive form the two methods of income maximization (use of total costs and unit costs).

EXERCISE No. 4. INCOME MAXIMIZATION AND UNIT COST CURVES

For a competitive enterprise (Fig. 33) :

a. At what price will it make no difference whether the enterprise closes down or keeps producing?

b. At what price will the enterprise operate at a loss?

c. At what price will the enterprise operate at a profit?

d. At what price will the enterprise operate at neither a profit nor a loss?

e. At what price will the enterprise close down?

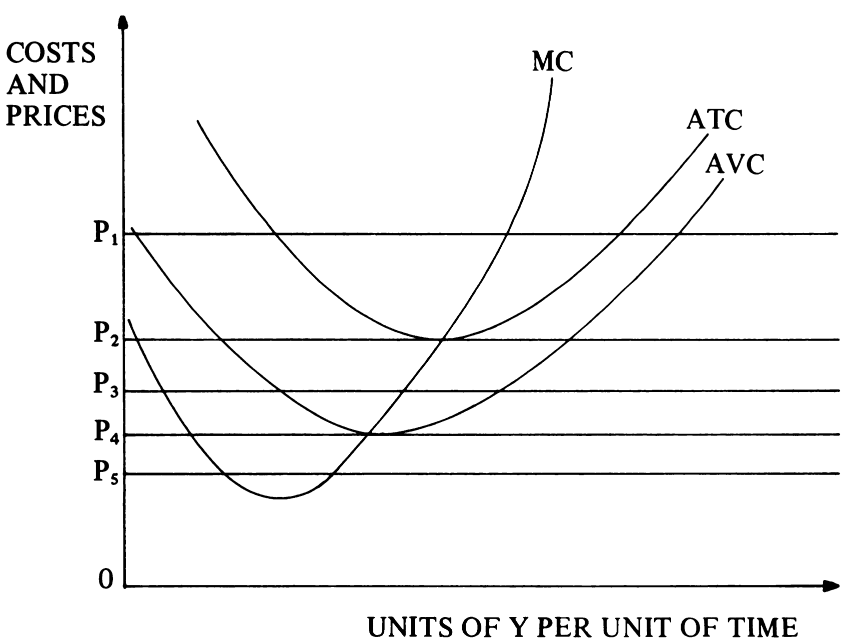

Fig. 33. Unit cost curves.

EXERCISE No. 5. LONG-TERM COSTS AND ECONOMIES OF SCALE

a. Draw a graph and indicate the long-term break-even point.

b. Define economies and diseconomies of scale.

c. Give two examples of internal economies of scale, both market and technological.

d. Give two examples of internal and external diseconomies of scale.

Do these examples represent market or technological economies?

EXERCISE No. 6. FACTOR-FACTOR RELATIONSHIPS

a. Using the formulas $MPV_{X_1} = P_{X_1}$ and $MPV_{X_2} = P_{X_2}$, determine the necessary condition for the optimum combination of resources of factors (minimum cost) at a given level of production.

b. Draw a graph to illustrate this situation.

c. Show graphically the following production relationships and indicate in each case the marginal rate of substitution:

– competitive products
– complementary products
– supplementary products

EXERCISE No. 7. APPLICATION OF THE THEORY

a. Briefly discuss the inconsistencies and problems which arise when economic theory is applied to the real situation.

b. Describe two methods for clarifying farm management problems.

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CHAPTER 4

METHODS OF OBTAINING INFORMATION FOR ANALYSIS AND PLANNING OF THE AGRICULTURAL ENTERPRISE

The manager of the agricultural enterprise must make daily and annual decisions even though the data he has may not be adequate. Some activities can be postponed until more or better data is available, but any farmer who postpones making a decision or refuses to take action is in fact making a potentially important decision. Generally, the appropriateness of the decisions will depend on the quality and quantity of information available. Similarly, the validity of any analysis by specialists in farm management will depend on available data. Consequently, it is important to study the firm's accounting records as well as any data obtained from questionnaires or such sources as lab reports from experimental stations.

In this chapter, we will detail the types and sources of data and how this information is obtained for purposes of agricultural management analysis. We will also explain the function of research in the context of the social sciences, justifying its usefulness and discussing the different types of consumers interested in making use of the findings of this research. Finally, we will describe several research methods in agricultural management used with very satisfactory results by many researchers in Latin America and other regions of the world.

TYPES AND SOURCES OF DATA FOR ANALYSIS AND PLANNING

At times the specialists will need to develop plans for completely new operating units, as occurs with settlement projects or new associative enterprises. This is a very important field in developing countries due to the emphasis being placed on agrarian reform programs in many Latin American countries.

Although interest in settlement projects is high, much of the most productive land in Latin America is already being used for agriculture. Consequently, the specialist will more frequently be called upon to plan the reorganization of existing operating units, with or without the cooperation of current managers.

TYPES AND SOURCES OF DATA FOR ANALYSIS OF CURRENTLY PRODUCTIVE BUSINESSES

Both managers and farm management specialists are interested in making the most economic use of the resources available on individual farms, according to the various production alternatives. This implies the need to have access to data on resources, production alternatives and market prices of products and inputs. The data must always be relevant to the particular situation of the farm in question. Generally, information about the past operation of the business is a very useful point of reference.

From the above discussion it may be concluded that the following four principal types of data are needed for planning an agricultural enterprise:

a. a history of recent production activities and resource use;

b. an inventory of the quantity and quality of available physical and human resources;

c. estimates of various alternatives for future physical production possibilities; and

d. estimates of expected prices in various markets for the firm's different inputs and products.

Data from account books and other primary sources

The account books of an individual farm that has kept proper records for many years contain the majority of the historical information needed and provide an excellent basis on which to predict future events. However, the opportunities for effective planning are not limited to cases in which complete records are available; even when such records do exist, they must be supplemented with additional data.

A visual inspection of the firm's resources can provide almost all the information for inventory records, with the possible exception of the degree of the farmer's indebtedness. Current land use is also a factor which can be observed directly. Businesses or cooperatives that buy agricultural products or sell supplies can generally provide precise records of their clients' purchases or sales. In addition, the standard of living enjoyed by the farmer and the family can provide at least a partial check of income level.

Data from secondary sources

Necessary supplementary information generally includes areas or tasks that have not played a part in past activities of the business, as well as future prices for the various inputs and products. This information can be obtained from the following secondary sources:

- findings of technical research conducted by governmental agencies, experimental stations, universities, and other organizations; of particular interest are data related to soils, yields, and improved varieties and practices recommended for the various farms in the zone;

- processing plants (cotton gins, canneries, milk pasteurizers, etc.); central markets are generally good sources of information on some or all of the following: prices by product quality, yields per hectare, and cultivation methods in use;

- climatic data which can be obtained from official statistical reports published by various organizations;

- information on plans for public and private development or agricultural endeavors in the region.

Secondary sources of data cannot completely replace the farmer's memory, although this is a source many specialists judge to be highly unreliable.

The value of memory data depends in part on the farmers' willingness to provide accurate information, and in part on the skills and experience of the interviewers. If the farmers are not interested in providing detailed information, if they feel their reputations in the community could be threatened or that precise data will expose them to the danger of higher taxes or of losing their land to agrarian reform projects, their memories may become quite short. These inaccuracies can be easily detected by applying simple tests useful for discovering various sources of error when data about rural businesses are obtained through the recall method.

TYPES AND SOURCES OF DATA FOR NEW AGRICULTURAL ENTERPRISES

The task of obtaining necessary data is generally more difficult for planning new businesses than for reorganizing existing firms. Land resources are often untried in new areas, and studies have frequently been limited in scope. The future operators and their families have rarely been identified beforehand. But in any case, these operators will clearly be unable to provide much experience or training in how best to operate under the new conditions. Nevertheless, the basic data to be gathered in planning a settlement project include the following (Carrol[3]):

Inventory of physical factors which determine present or potential soil use

The most important physical factors can be found in soil maps, which should be interpreted according to limitations on land use during different seasons and under different economic conditions. Together with soil maps, physical inventories should also include ecological and forestry maps. In most countries, such physical inventories are either nonexistent or inadequate for various reasons, including a lack of trained personnel, inappropriate or inconsistent methods, or funding problems. Also, there appears to be little awareness of the true importance of these studies.

Physical inventories are not very useful if the maps do not indicate zones which are more or less homegeneous in nature. These inventories should also indicate possible alternative uses as well as the conditions or current use of resources. The uses of public and private property should be compared.

Data on public services and existing development

An inventory of the nature, quality, and scope of available public services is necessary. This involves not only infrastructure, but also the service itself. An example would be the number of schools and teachers or the number of hospitals, available beds, and doctors.

Information on participants to be incorporated into the future business

It is helpful to define the work force available in the family and the community. Considerations should be given to the experience, education and management abilities of the campesinos who will be participating in settlement programs.

Data on future prices of products and agricultural inputs

Knowledge on the general panorama of basic factors which will affect future prices and price trends must be supplemented with data on possible future prices of products and agricultural inputs.

In some cases it is necessary to obtain more detailed information on seasonal price variations. For example, today no egg producers can hope to achieve a degree of success in their business unless they adjust their production to seasonal price variations for large, medium, and small eggs. In other situations, relative long-run price trends assume a special importance. Planners of coffee plantations in Colombia and Brazil should take into account not only the emergence of new coffee developments in other countries during the last few years, but also the establishment of the International Coffee Organization (ICO) and future price fluctuations.

Data on alternative production possibilities for agricultural enterprises

This includes the input-output relationship available to producers with the resources they have at hand. Farm planners in Colombia, for example, should understand the technical possibilities for replacing coffee with other crops in areas where this is possible. They should also know how wheat, corn or cotton respond to different levels of fertilization, irrigation and other types of variations in production methods. Egg producers cannot benefit from their knowledge of seasonal price variations unless they also understand how the production of large, medium and small eggs varies according to the times of the year in which the hens are hatched. They must also understand methods for changing these production patterns with the use of artificial lighting and other management practices.

It is very difficult to obtain this information for new areas. In many cases it is necessary to make estimates using baseline data from farms in regions very similar to the new zone. In addition, the findings obtained in experimental stations around the world can be useful when they are located in areas, and exposed to conditions, similar to those of the zone being opened for settlement.

RECORD-KEEPING SYSTEMS FOR FARM ENTERPRISES

As was mentioned above, the proportion of farmers in Latin America who keep records appropriate for providing a satisfactory planning base is probably quite small. As more and more farmers receive assistance in business analysis, their farms will gradually be transformed into more commercial enterprises; and as growing numbers of producers are required to prepare income tax statements, a real need to develop useful record-keeping systems will be felt. Many farmers will be faced with the problem of designing bookkeeping systems suited to the needs of their firms.

The creation of associative enterprises, as described in Chapter 1, will also require similar efforts to create systems of record-keeping and accounting.

In these cases the specialists may find themselves called upon to assist in the establishment of a more or less standardized format for record-keeping systems. The use of mechanized accounting methods in farm records is under consideration in Europe, the United States and some countries of Latin America (Colombia, Peru and Mexico, among others).

Technicians or farmers must develop accounting systems capable of dealing efficiently with the particular needs of agricultural enterprises. Sometimes simple records will be sufficient, while at other times a greater effort will be needed. Some of the basic conditions for the designing of these records are discussed below.

WHAT ARE THE OBJECTIVES OF RECORD-KEEPING?

Records are kept for at least the following five important reasons:

a. complying with existing requirements for tax statements;

b. measuring the success of the financial operations as well as year-to-year or month-to-month progress;

c. providing a point of comparison with the previous performance records of the firm or of other comparable enterprises;

d. providing a continuous source of data useful in planning the agricultural business; and

e. helping in the acquisition of credit from banks and other financial sources.

HOW EXTENSIVE SHOULD THE RECORDS BE?

Records can vary in scope from one simple file for a limited and specific purpose, such as a field map on lime applications, to an extensive set of records containing all reports on the agricultural enterprise and the family finances. Five possible types of records are:

Simple cost accounting for a product line

This is a record of income and expenses for a single product or agricultural endeavor, such as potatoes or cotton.

Advantages. It provides operational data useful for planning.

Disadvantages. It is based on arbitrary distributions of combined costs and has little value for the objectives mentioned above.

Tax records

As a minimum, tax statements must include information from records on revenue, expenditures and depreciation.

Advantages. These records reflect the economic health of the firm and provide tax data with a minimum of effort.

Disadvantages. They may provide inadequate data for evaluating the operation of the individual production lines of the firm and for planning future changes. They do not cover the revenue or expenditures of the family as distinct from the agricultural business.

Overall records for the agricultural firm

These include the tax statement records, together with inventories and quantitative data on the development of individual production lines. Other partial records may be necessary for providing complete information on the operation.

Advantages. With only a small additional effort over and above the minimum necessary for tax statement purposes, these records can provide considerable data for planning and analysis.

Disadvantages. They do not provide a complete report on family finances.

Overall records on the agricultural enterprise and family finances

This record includes tax statements and family financial planning information, as well as data on company finances.

Advantages. It satisfies all the objectives listed above. In addition, the records include revenue and expenditures of the firm and the family, as well as cash balances, thus providing a basis for on-going crosschecks which may uncover entry deletions.

Disadvantages. The benefits may be too minor to justify the effort involved, unless records are planned very carefully, maintained faithfully, and interpreted judiciously.

Complete cost accounting

All expenditures and revenues of the agricultural firm are recorded and posted to the accounts of the various activities or production lines.

Advantages. They measure the financial status of each individual production line.

Disadvantages. They generally rely on arbitrary assumptions about the distribution of joint costs and are of relatively little use for planning, in comparison with the effort and skills required.

WHAT TYPE OF INFORMATION SHOULD GO INTO THE RECORDS?

As no two farms have the same needs, a number of uses can be found for the different types of information recorded in the firm's books. Some of the most common items are listed below, according to their application to firm of to family:

Information on the agricultural enterprise

- operating income and expenses;
- capital investments and income;
- volume of input and output;
- input and output prices;
- depreciation of machinery, buildings, land improvements and livestock purchases;
- annual inventory, including quantity and value of land, depreciable property, livestock, feed and other supplies;
- daily and monthly inventories of animal count, and of the volume of feed in storage; and
- data on accounts payable and receivable.

Family financial information

- family income and expenditures;
- purchases, by quantity and price;
- data on accounts payable or receivable;
- lists of insurance policies and other similar documents;
- purchases and inventory of household goods and other personal property; and
- statement of financial balance.

WHAT ARE THE CHARACTERISTICS OF A GOOD RECORD-KEEPING SYSTEM?

Certain characteristics are very desirable for the records, aside from the broad spectrum of unnecessary books that could be maintained but would be too extensive to be practical. Some of these recommended elements are listed below, with examples for a commercial poultry operation. The points could easily be adapted for use in other businesses:

Records should be complete in terms of previously established objectives. The omission of a few key items can considerably reduce the value of a set of records which may be acceptable in all other aspects. For example, if the data needed to calculate the average number of laying hens were absent, the analytical value of the records would be limited in spite of their accurate figures on total expenditures, revenue, and egg production.

Records should be accurate within certain acceptable limits. Errors and omissions can frequently be pinpointed and corrected by simple confrontation procedures. For example, the number of birds present at the beginning of the year, plus additions, less sales and deaths should be equal to the number of birds at the end of the year. Likewise, cash on hand at the beginning of the month, plus cash receipts from the farm and family, less cash expenditures should be equal to cash on hand at the end of the month.

Records should be simple and should be in line with stated objectives. A system of records is of little value if it cannot be readily understood, easily maintained, and quickly interpreted. Errors can be multiplied in a system that requires entries to be copied repeatedly from one part to another.

Records should be convenient. This is especially important for making simple, original entries at the place where the activity or transaction occurs. The logical place to note egg production, for example, is not in an accounting book in the office, but on a record sheet located in the laying shed.

Records should have sufficent space for making orderly notations of all details. Effort is wasted and accuracy is lost when the record format does not provide enough space for each entry.

Records should be accessible. They should provide easy access to data on given transactions. For example, the accountant may need information on a transaction made five years ago. He can find it by seeking out headings, such as "taxes", and reviewing a series of entries in chronological order.

Records should be broken down according to stated objectives. An adequate number of columns or rows for detailed classification will eliminate certain problems, such as the need to reclassify "feed" expenditures in order to determine separate totals for "feed for layers," "feed for roosters," "feed for milk cows," etc.

ADDITIONAL CONSIDERATIONS

Once the general breadth of a series of records and the type of information to be recorded have been determined, certain special decisions must still be made concerning the design of the system. Four of these decisions are:

The cycle of the accounts. Many farmers base their income statements on the calendar year, using it as their accounting period; however, in some cases a different fiscal accounting year is determined advisable. There is also controversy on whether or not to draw up periodic summaries during the fiscal year. Such summaries should be monthly or quarterly, but there are cases, as in recording egg production on a poultry farm, in which a four-week period is recommended. Summaries may be necessary to record weekly production or daily income.

The focus of accounts: cash receipts or inventories. Accounting based on cash receipts offers certain advantages of simplicity, but a method that can be adjusted for inventory changes can give a more accurate idea of farm operations when large year-to-year fluctuations are common. In some cases the determining factor will be the requirements of tax statements. If expenditures are charged to open accounts and recorded only as total payments, many details needed for analysis of the firm may be lost.

The system for making original entries. Many farmers satisfy their needs by keeping a series of records instead of a single accounting book. The logical place to make original entries is where the activity occurs. That is, milk production is recorded in the dairy barn, egg production in the laying sheds, and cash expenditures in a small pocket notebook. If separate methods are thoughtfully designed, the system of making rapid, accurate entries can be greatly enhanced. Preliminary planning is a must if duplication of entries is to be avoided and if an overall summary of information is to be obtained.

The use of summaries. Original entries should be kept for chance reference, but they do not really serve their objectives unless they are put into summaries of certain time periods or types of work. The task of planning original entries and developing useful summaries are closely related, because the type of summaries used depends on the quality of information contained in the records. Original records should, in turn, be planned with an eye to the type of summary to be made.

RESEARCH: KINDS AND USES

There are many ways to classify the various types of research that characterize the field of agricultural management. We will not attempt to include here an exhaustive classification or list of all studies possible; rather we will group together the types of research that have been common in the various countries.

TYPES OF RESEARCH

The following considerations can provide a basis for classification (Eleventh International Conference of Agricultural Economists,[13]):

a. How can the organizational structure and land tenure systems be optimized for existing farms, in view of available resources? Institutional restrictions determined by the attitudes of the government are a key factor.

b. How can resources be added or combined more efficiently so as to increase farmer income by boosting productivity?

c. How can labor and other scarce resources, such as capital, be most effectively distributed among different types of farming operations?

   With the use of modern technology comes a reduction in labor needs. The social and economic implications of new, labor-replacing technology must be closely examined, and other employment possibilities on and off the farm, which are capable of absorbing the newly freed labor force, should be sought. This type of research opens the way for more humane agricultural policies that provide employment opportunities for workers displaced by the introduction of new technology.

d. How can farmers be provided with levels of income comparable to those of other sectors of the economy by changing the production and tenure systems for using available resources?

e. How can the optimum level of production be determined for the agricultural enterprises, taking into account not only economies of scale, but also the economic implications of alternative policies? The new models for associative enterprises allow for greater volumes of business, and consequently it is necessary to study different organization and production systems which are adaptable to large enterprises. Policies for agricultural research, credit, development and technical assistance must be adapted to these new situations.

f. What is the impact of various price policy alternatives on agricultural production plans? This should be examined for both the domestic economy and the exporting sector.

g. How can production be organized by areas and regions so as to maximize comparative advantage and establish national and regional development priorities? This area of research is very broad and requires the coordinated efforts of agricultural researchers and economists. It includes studies of the types of agricultural operations being used. Farms must be classified by size, labor needs, and other economic criteria. This category also includes studies of the factors that influence cost and revenue in agricultural enterprises of different sizes and types.

h. The final area of research involves the social sciences. These studies seek to determine how campesinos learn about new production techniques and why they decide to adopt or reject them.

Various authors have proposed systems for classifying research in agricultural management. For example, Christensen[5] groups research into three categories:

a. Research which is primarily descriptive of changing economic conditions on the farm. This category includes the following studies:

   1) types of operations, by size and by other economic criteria;

   2) costs and income and the factors which influence them on farms of various sizes and types; and

   3) agricultural methods as they relate to the use of labor, machinery and agricultural supplies (seeds, fertilizers, etc.) This area also covers the efficient use of resources on the farm.

b. Research on modifying the organization and operation of the farm to improve efficiency and increase net income. Three areas can be distinguished:

1) research that concentrates on a single practice, phase, or production line;

2) research which views the total farm as one economic unit. This could involve changes in overall production methods, marketing or farm management; and

3) research into regional – and national – level changes in production and resource use needed to make agriculture an efficient industry. Examples could include changes in consumer habits, changes in the size and composition of the population, and changes in the comparative advantages of different production areas or products.

c. Research on how to overcome obstacles to production and improve systems and methods of farming. This seeks to determine how campesinos learn about new production techniques and what factors help convince them to adopt new methods.

These sample areas indicate that the field of agricultural management research is very broad. It is important for each country or region and each group of participants in agricultural management to select the areas most relevant to its own needs and most suited to the overall national economic development program. At the same time research priorities should be established.

USERS OF FARM MANAGEMENT RESEARCH

Many people feel that farm management research is useful only for professionals, agricultural economists, or others who may have a special interest in the field. In fact, these research findings are potentially applicable by the following five groups of individuals:

Farmers

This is the largest group, for as was noted earlier, the major objective of research is to help farmers improve the efficiency of their firms in order to stabilize and increase their income and solve the social problems on the farm. If they are successfully provided with information or assistance that helps them improve their technical, economic, social or administrative operations, greater cooperation can be expected from them.

Researchers and extensionists

This group includes anyone who works in research or extension. Farm management work helps make these technicians aware of the major problems of farm production, in its physical as well as its economic and social aspects.

Researchers. In some countries, socioeconomic research findings are used in experimental stations to make decisions on how best to organize basic research on crops, cattle and other production aspects. Also, information-gathering projects can help in deciding how to distribute available research funds among the problem areas of the different branches of the agricultural sciences so as to achieve the most economic use of these resources.

It would be safe to say that in many Latin American countries the findings of farm management and economic research do not influence decisions concerning the problems to be studied in experimental stations. In addition, the findings of these research efforts are all too often ignored when decisions are made determining priorities for budget distribution among problem areas to be researched.

Extensionists. These workers must provide advice on insect and disease control, crop rotation and use of fertilizers. However, they often overlook factors of regional input and labor supplies, product prices, and the possible effects their new techniques could have on farmer income.

For this reason their advice often proves to be more detrimental than beneficial, and this is why communication and extension services have so often failed to produce positive results in many countries. An extensionist trained in farm management can look to these research finding for useful, concise information and use it as a basis on which to design economic development programs in a given area.

Directors of commercial enterprises

The third group includes directors of commercial and industrial firms associated with agriculture. These people take an interest in the prosperity of the farmers because their own sales and purchases are dependent on the agricultural sector. In Mexico, Brazil and other countries, many commercial firms actually hire agricultural management experts to sell their products.

Agricultural policy makers

Almost every country in the world has programs for agricultural production, land use, product processing and product prices. It is almost impossible to develop sound programs and policies for agriculture without access to the information provided by farm management research.

For example, some Latin American and Asian countries have looked to farm management research findings for the basic data needed in the evaluation and projection of development programs such as land rehabilitation, settlement, irrigation and drainage. For many years agricultural credit programs, especially supervised credit, soil conservation districts, and development plans for farms in newly-opened agricultural areas, have relied on the findings of these studies.

Educational institutions

Research and analysis are the primary resources for educational programs in farm management. Courses in this discipline can rarely be taught without some type of student research; this not only helps make students familiar with research methods, but also shows them the practical application of principles discussed in the classroom.

A method which the author has used successfully for many years is to help students develop surveys and case studies and work up graduate theses and seminars on various topics of farm management.

THE FUNCTION OF RESEARCH

The principal purpose of farm management research is to discover how farmers use their resources (land, labor and capital), analyze this information, and draw conclusions about the technical, social, administrative or economic problems affecting the operation of the firm. To this end, the farm is analyzed as a single unit. Similar analysis can be done for a group of enterprises or farms in a given region or country.

This section will discuss the function of research and the need to orient it toward problem-solving.

Public confidence in the power of research has been growing during the past century. Increases in public and private research budgets reflect a strong belief that scientists can find solutions to many difficult problems in the natural and social sciences. The researcher is not simply an explorer in search of knowledge, but a problem-solver whose work must be completed in time to solve high-priority problems before it is too late.

The idea of research as a problem-solving activity is relatively modern, and it is still very common to find different, antiquated opinions about what researchers do and how they go about doing it. In fact, researchers themselves frequently develop their problem-solving tasks following guidelines for specialized types of research. Generally, researchers like to think they have embarked upon a deliberate, laborious search for the "eternal truth," where no scrap of information is so insignificant, and no effort is so difficult or requires so much time, that it cannot be justified.

However, the benefits provided by this "eternal truth" are not always sufficient to solve modern, pressing problems, for the most useful and practical research findings for problem-solving all too often prove not to be "eternal." Quite the contrary, research findings capable of making concrete contributions to the solution of real problems are frequently applicable or valid only under the particular conditions of a specific locale during a given time period.

Even in the natural sciences, research findings are often of limited validity and importance. The highly lauded efficiency of DDT and other modern, organic insecticides gave rise to the multiplication of resistant varieties of insects. Experiments with antibiotics have had similar effects. Research findings in the social sciences often become obsolete even more rapidly, since many of the problems that need to be solved arise from circumstances which are unique and transitory, while some of the most basic problems show promise for immediate solution.

The transitory nature of many of today's problems tends to have a limiting effect on reasonable levels of expenditures and to reduce the time allowed for study before the best alternatives can be presented to the sponsor of research. For this reason, researchers must learn to put into practice their own economic theories on resource distribution. Resources should be distributed among various activities on the basis of equi-marginality.

However, the problems to be solved are generally complex, and many variables come into play, for the success of an agricultural enterprise is subject to an almost unlimited number of variations. Social relations inside the community are equally complex. As problem-solvers, social scientists should be prepared to develop rapid analyses of complex situations and produce the best possible responses within given time and budgetary limitations.

These comments are in no way intended to discredit research efforts that seek to develop valuable basic knowledge without a view to applying it to the solution of existing problems. Such research can stand on its own merits. This does not mean that any research can be justified as "basic research" simply because it does not contribute to the solution of a problem. It should be recalled that a great deal of research receives financial assistance specifically for producing results of immediate practical value. Perhaps a better term for this type of endeavor would be "problem analysis," thus avoiding certain common applications of the word "research."

There is a central objective to which practically all analytical activity in the field of farm management is subordinated. It is how to make agricultural firms operate successfully in terms of the personal values of the farmer and given social goals. These values or goals have both monetary and non-monetary dimensions.

In their work toward this central objective, analysts concern themselves with each agricultural firm as a whole. They are interested not so much in measuring certain attributes of many farms, as in studying all the elements of a single firm. Researchers do not try to measure mean interactions of a few variables in a given region, but to examine the specific interaction of many variables in the context of an individual unit. Their gaze does not turn to the past, but to the future, where new variables may begin to modify the interpretation or application of the findings of previous studies.

Although problem analysis generally includes the study of past events, few problems can be resolved without forecasts of future expectations. Such forecasts can, at times, be based on firmly established principles and laws. Nevertheless, the analyst needs to depend to a considerable degree on personal judgement when applying hypotheses which have not been fully verified by historical evidence or by logical reasoning. The researcher must dedicate a great deal of time to formulating specific hypotheses about given situations and testing these hypotheses with empirical and logical analysis before using them to develop forecasts of future events. The basis on which forecasts are founded is generally unstable; however, without some kind of firm foundation, the analyst will be able to solve few problems.

The development of useful hypotheses is an important element of problem analysis. Once the hypotheses are carefully selected, they can be tested on the basis of concrete evidence, such as the past behavior of individuals or groups, or by logical reasoning. This could require calculations ranging from elemental arithmetic to advanced mathematics. Isolated facts are rarely adequate for solving problems; for information to be useful, it must show the proper relationships between factors through the development of ideas, hypotheses, principles or laws.

Social scientists often reject the task of developing complex, plausible hypotheses through a process of logical reasoning based on all available evidence. Instead they appear to prefer a more routine approach for: 1) gathering and synthesizing facts and 2) using these facts to test randomly selected hypotheses against a historical setting. This type of testing process may provide a more or less exact historical description without providing any kind of solid base on which to forecast. In addition, the possible occurence of false correlations has already been documented in many papers. Before placing much confidence in forecasts derived from historical behavior, a plausible explanation must be provided as to why things happened the way they did. In addition a basis is needed on which to judge whether or not similar factors will be operating in the future.

The true problem-solver must emerge from the laboratoy with definite conclusions on future behavior, rather than merely a collection of relevant or irrelevant facts about past behavior. In other words, considerable personal judgement must be exercised in the determination of causal relationships.

RESEARCH FOR PROBLEM–SOLVING

This approach to research in farm management is oriented toward problem-solving. The following model developed by Harbovsky[8] is useful for identifying and clarifying problems and for orienting research to help find solutions.

According to the most widely used definition, a problem exists when an individual (or group) perceives a difference between an existing situation and a desired or normative situation. The individuals must be convinced that the problem has a solution; in other words, once the goal has been identified, they perceive the possibility of achieving it. They should also understand the restrictions or uncertainties that will attend the process of moving from the present status to the new situation that will exist when the objective has been reached. The difficulty arises from uncertainty, which is one of the reasons problem research exists at all.

Figure 34 is a schematic representation of a simple problem. The present situation is given on the left and the goals, on the right. Alternative solutions appear in the middle, and the broken line represents the obstacles or restrictions on achieving the goals.

The goals and objectives provide a suitable means of classifying the problems to be studied in agricultural management research. The first group includes farmer problems, generally concerned with income-raising goals measured either in monetary terms or in units of profit. The second group is made up of the problems faced by agricultural policy makers. Objectives may include higher community income at a given level of resource, and/or social well-being goals related to income distribution. The third group of problems has to do with research-related goals pursued by the researchers themselves. This group is of a somewhat different nature; however, it receives considerable attention in the form of methodological studies.

The first two categories of problems are often two different sides of the same coin, for they both involve adjusting agricultural production to the expectations and goals of the individual producer and of society. For example, farmers may view the basic problem of increasing agricultural production as a means of obtaining greater income for their families, while on the level of national nutrition, considerations on the physical product may override those of income distribution.

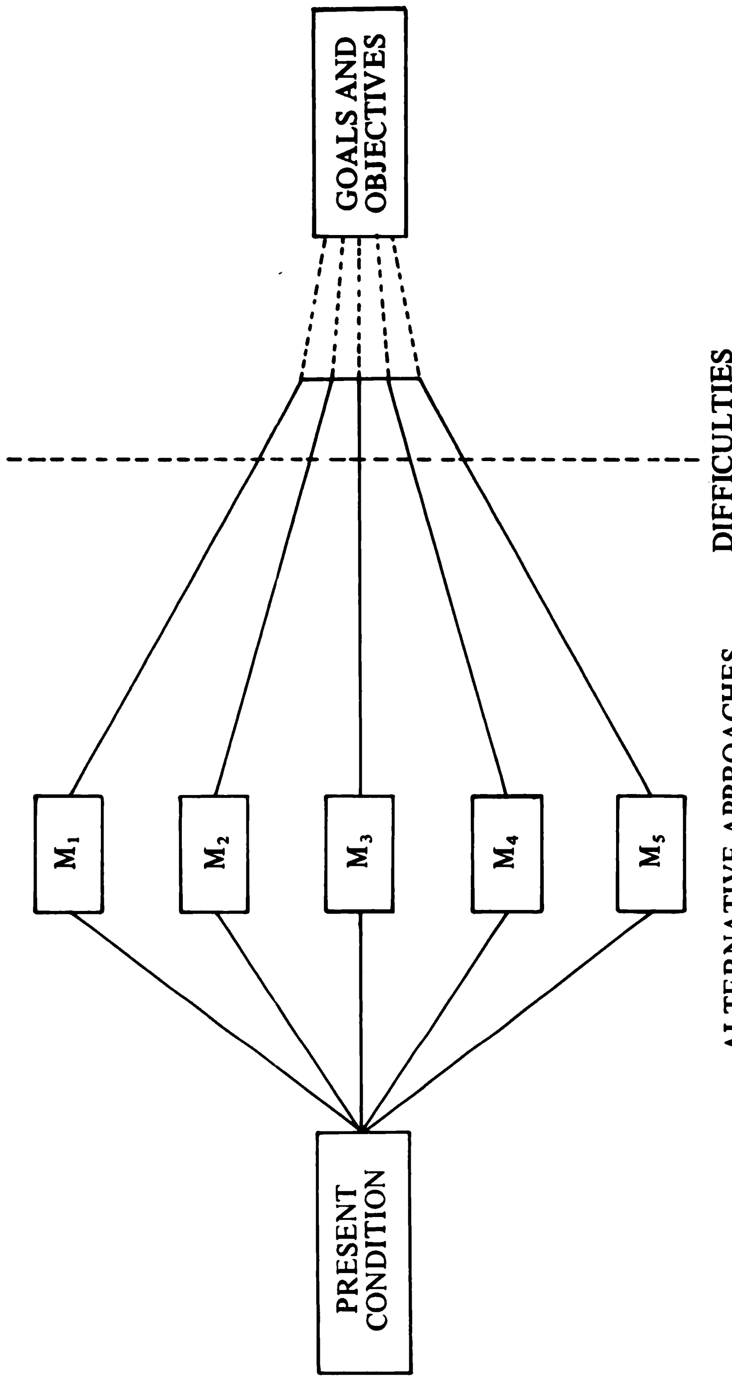

Fig. 34. Schematic drawing of a problem, adapted from the Harbovsky[8] model.

In spite of the fact that these problems stem from the same basic phenomenon, the various goals mentioned above will require different solutions. They can be identified not only in terms of the means available for solving real problems, but also with the knowledge necessary for selecting the most effective alternatives for the solution of present problems. The first step in identifying the difficulties of farm management research is to understand the various elements of the chosen goals.

Although observation is undeniably a useful means of identifying problems, certain basic principles can facilitate the task. Three key elements must be considered: 1) goal or goals pursued, 2) the obstacles to be eliminated in order to reach goal(s), and 3) the means for achieving the goal(s).

Identifying desired goals is a difficult task. For example, in a highly developed economy it is easy to single out the goal of maximizing farmer income; however, this frequently leads to serious errors. In subsistence or semisubsistence agriculture, as exists in many Latin American countries where the socio-psychological setting plays an important role in the farmer's goals, income maximization as a goal is not very appropriate; even if it were, it would be difficult to achieve. Goal identification by politicians or by policy makers is even more difficult, as many of the priorities prove to be contradictory or conflicting (for example, full employment and high levels of mechanization). In addition, they are highly unstable over time.

The objectives or goals of researchers are also difficult to identify. In most cases, the definition can be drawn by presenting "new knowledge" as the objective; but this fails to specify the type of knowledge involved. Do we seek knowledge for solving a specific real-life problem? Is it a question of theoretical structures only tangentially related to problem-solving? Or as frequently occurs, is it an exercise in demonstrating new research methods?

This eliminates the task of seeking procedures for achieving undefined goals. If the means prove to be elusive, chances are there are no real problems worth the researcher's time and effort. If possible approaches are to be perceived and subsequently identified, a good understanding of the agricultural production process is necessary, and the environment in which the solution may be found must be established. This information can be found in available descriptive information and research experimentation. As more information is made available, the task of the researcher becomes easier. Hypotheses can be formulated on the basis of proven relationships within the agricultural production process.

At this stage of seeking approaches, the agricultural economist needs the cooperation of other scientists, especially the agricultural researcher and sociologist. Thus the importance of interdisciplinary work becomes clear.

This understanding and awareneses of the situation helps researchers recognize the difficulties which may arise during the process of goal achievement. The first difficulty is the lack of adequate information, a useful point of reference when the feasibility of research projects is under consideration.

When a real life problem is proposed for agricultural management research, the following basic questions must be considered:

a. On the basis of existing information, can a model be formulated explaining the variables and relationships of an actual problem in farm management?

b. Can information be obtained providing empirical measurements of selected variables?

c. Can this information be given a form that will help farmers and policy makers to reach the desired solutions?

d. Are the necessary resources available?

Although these questions concern the feasibility of research, they are largely a function of the difficulties existing in the real world. The solution of these research problems will produce information useful in solving the problems affecting farmers and policy makers.

If this general scheme is acceptable, we can go on to consider the types of knowledge we hope to obtain from farm management research. Two areas come to mind. The first would provide an explanation of current production structures and their bearing on productive processes in the future. Although this is often known as descriptive knowledge, it has an analytical component that should not be overlooked. The second area is a result of the findings or knowledge produced by the first, and involves predicting how individual farmers, groups of farmers, and institutions will respond to future changes in: 1) prices, 2) resource availability, 3) technology and 4) institutional factors. Because these changes frequently trigger adjustment problems, the last two categories receive a great deal of attention in agricultural management research for problem-solving.

The model in figure 35 should provide a better undestanding of the relationships between "problem areas" and the classification system given above. The bottom part of the diagram shows how goals of farmers and policy makers influence research objectives. However, three arrows point up toward the next rectangle, indicating that researchers have their own interests beyond the influence of the farmers and policy makers. The agricultural production process is influenced by changes in prices, resource availability, technology, and institutions, all of which contribute to "production and marketing problems."

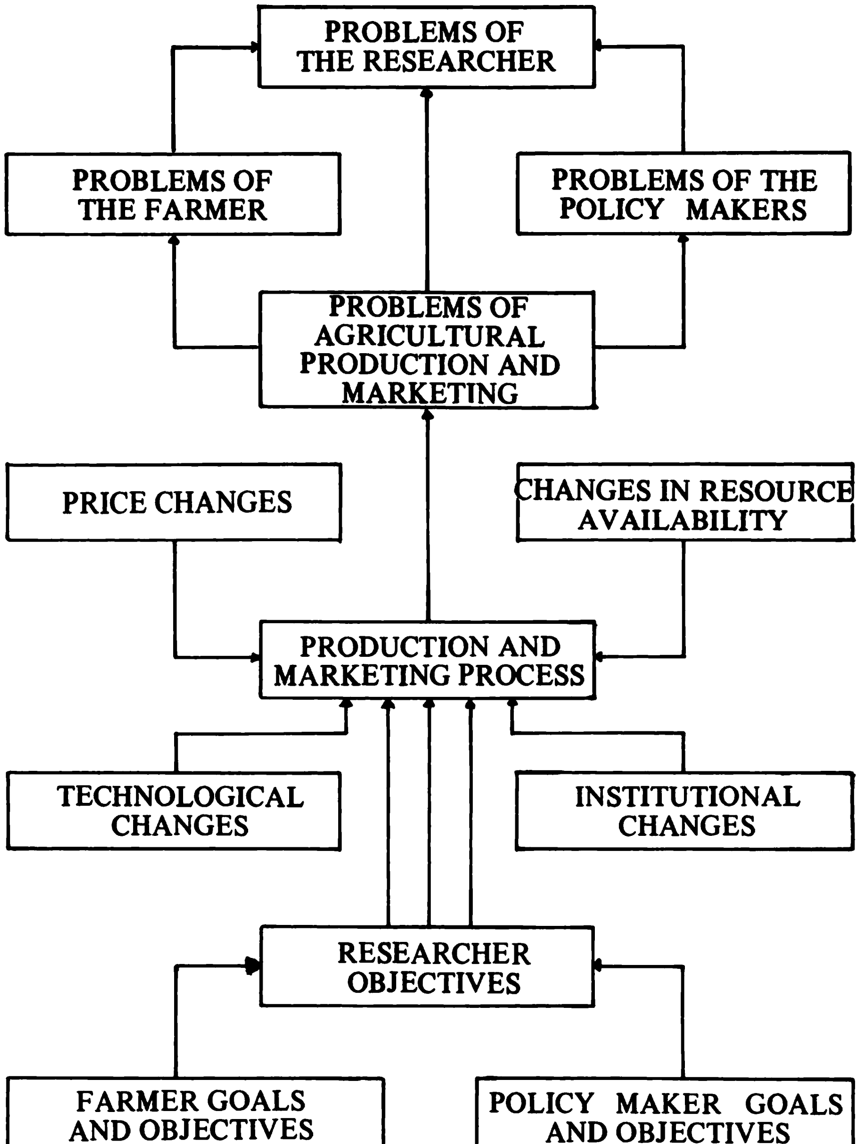

Fig. 35. Diagram of the relationship between the classification of objectives and goals, problems areas, and management research problems. Harbovsky[8].

The goals and objectives of the three groups working with these problems appear in the upper part of the diagram: "farmers, policy makers and researchers." The arrow connecting researchers' problems with agricultural and marketing problems show the special links that unite these concerns, directly and through the other two groups.

The remaining conditions for identifying problems of agricultural management and seeking to solve them could be summarized in the following considerations the researchers should make:

a. they should place themselves in the shoes of the farmer or policy maker who will be using new knowledge for meeting needs and goals;

b. they should understand the agricultural production and marketing processes, as well as the environment in which they take place; and

c. they should determine what information is immediately available and what information is needed for problem-solving.

ALTERNATIVE RESEARCH METHODS

There are many specific techniques available for obtaining and analyzing data. Among them are statistical methods and case studies.

The purpose of case studies is to acquire an understanding of the characteristics and behavior of a single real-life case, whether a farm, a person, a family, a corporation or a community. In a purely statistical study, by contrast, the individual case loses its identity and is helpful only for presenting selected characteristics of a population or universe. Any observer of natural phenomena must chose between the two systems or learn how best to combine them.

Conceptual or logical reasoning is a third analytical method. It is different from the other two in that it does not necessarily involve manipulating concrete data. Logical reasoning can be combined with empirical methods either in cases or in an overall universe.

Logical analysis and analysis based on facts are generally accepted as complementary systems. Similarly, case studies and statistical studies can be considered complementary if the differences between them are clearly understood.

THE STATISTICAL STUDY METHOD

Fisher[7] defines statistics as the study of populations or groups of individuals, as opposed to individuals themselves. A typical statistical study, for example, would describe the average size of relevant enterprises or the relationship between enterprise size and income. It should be noted that the group is described in terms of certain selected characteristics or the relationships between these characteristics. In practice, when two characteristics are found to be interrelated, they are generally given causal significance. In this sense, statistical findings can provide greater assistance for future action.

Statistical research is commonly designed to test one or more hypotheses or apply some principle. For research on size or income, for example, the researcher could be testing the hypothesis that greater size (volume of business) provides greater income.

A statistical study implies a high degree of selectivity in data collection. A small number of selected characteristics is measured, or several specific relationships between a few selected variables are examined. This is in contrast to the case study method in which any or all aspects and characteristics of the selected case would undergo a coordinated study.

The importance of selecting and defining the universe

Farm management studies have their own methods for selecting and defining the universe, different from methods designed for collecting and analyzing overall statistics as in an agricultural census. In such a case, the universe is often defined by political-administrative divisions, such as departments, provinces or cantons. This type of universe selection presents problems in the management field because it combines operations of every kind, thus making the analysis of the farm enterprises difficult or impossible.

In farm management it is important to know how to draw comparisons. Yields per hectare of a certain crop during a given period cannot be compared with yields per acre of another crop unless a similar unit of measurement or some point of reference is available. Organizational efficiency cannot be compared with any precision among farms under diverse ecological conditions, for any differences could easily be the result of environmental variations or ecological influences, rather than differences in the level of efficiency.

Defining the universe is an important step because it determines the results of the research. Unless the universe is clearly defined, the analysis cannot be good, for this initial error of judgement in selecting the universe will be compounded by management research errors, such as sampling errors, errors in collecting data or converting it to other comparable measures, and logical errors that may occur when the information is analyzed and interpreted.

The problem of sampling

Although sampling techniques will not be discussed here, it is worth noting the importance of a carefully planned sample design in order to avoid unnecessary loss of time and money, and to guarantee the usefulness of the study. Hundreds or thousands of heterogeneous farms may exist in an agricultural zone, and it is impossible to survey all of them. Every farm included in a survey means more time and personnel and, subsequently, more money. Thus, a representive sample is selected, and the information gathered is used for the study.

The number of enterprises to be surveyed is the sample size, and it depends on such factors as: the variability of local farming conditions, the level of precision desired for the study, the type of tabulations to be used, and the funds, personnel, time and equipment available for the study. Sometimes a large number of farms must be included, as when operations are highly dissimilar, or cross tabulations will be made for comparison purposes. In other cases, a small sample is sufficient. Maps of land use, agricultural regions or economic level are useful for drawing stratifications for classifying farms or production units by certain representative characteristics.

The stages of a statistical study

This will not be a detailed description of the stages of a statistical study, for any good statistics textbook can be consulted for more information on the subject.

Croxton and Cowden[6] describe the stages of a statistical study as follows:

- developing the general plan (this includes defining the problem and determining the universe);
- preparing and testing questionnaires;

- selecting the sample;
- compiling survey data;
- evaluating the questionnaires: this includes calculating, coding and reviewing to determine whether responses are complete and have been correctly interpreted;
- tabulating data: this can be done manually or mechanically, depending on the nature of the study and the funds available;
- preparing tables and graphs;
- analyzing and interpreting results.

THE CASE STUDY METHOD

Case studies have served two different purposes in farm management methods: 1) descriptive exploratory studies and 2) budgetary analyses used by economists in their studies of administrative decision-making.

Mathematical programming methods have recently been adopted within the framework of certain cases, although the results cannot be described as true case studies, as they are more hypothetical than real. The same could be said of many of the comparative budget studies used for years by the U.S. Department of Agriculture.

How to select cases and draw conclusions

Case study researchers are anxious to develop useful generalizations from their studies and try to select their case studies with this objective in mind. A common formula has been to divide a given universe into strata of more or less homogeneous units, choosing a case to represent each stratum. These "representative" cases are then expected to provide the basis for developing generalizations about both the stratum and the universe of study.

While cases are sometimes selected randomly from each of the important strata, at other times a purposeful selection is made. In budget analyses or linear programming operations, simulated cases are often prepared to correspond to the arithmetic mean of the strata under study in terms of strategically important variables.

The idea of stratifying a universe of study and selecting a representative case from each stratum is predicated upon a clear understanding of all variables important enough to be used as the basis for stratification. The stratification process itself will be of little significance unless it is based on variables which have some bearing on the subject of the study. It would be possible, for example, to select a stratified sample based on the first letter of the farmer's name and the day of the week on which the owner was born, but such a stratification procedure would not generally provide a useful analysis of farm management. Without a preliminary understanding of the important variables, only limited success can be expected in the stratification and selection of representative cases from the major strata.

In line with these ideas, it would be impossible to select representative cases from each stratum of the universe of study unless a preliminary study were made of these cases. However, the value of the case study method lies precisely in its ability to help identify the most significant variables and hypotheses which should be developed in the first place. Therefore, the researcher does not have a strong basis on which to select cases that can be considered representative of the various situations present in the universe of the study.

This is why cases should be chosen regardless of whether or not they are representative of the most important variables; the idea is that the case study can shed new light on the question of which variables are really the most important. A "representative" case can in fact prove to be very unrepresentative, even though it may have been selected on the basis of group averages for many characteristics. This is because the researcher may find other variables which turn out to be more significant, or indeed because even the enterprises that come closest to satisfying the "average" may not have the same possibilities for change as a truly "average" enterprise.

Only after various cases selected randomly from each group or stratum have been analyzed, can a good indication as to the representative nature of the case be obtained. If similar conclusions are drawn for three or four cases, we can expect a greater number in the group to show the same characteristics or to behave similarly. On the other hand, when three or four cases from the same stratum or group possess significantly different characteristics or behavior, it could be an indication that the group is less homogeneous than was expected when the sampling procedure was designed.

Of course, physical and human resources do not vary greatly, and for this reason there is a certain amount of similarity in opportunities for change and in production patterns. This is why a series of case studies is enough to provide the basis for developing limited statistical generalizations. However, this is not necessarily the major goal of the case study method, for the case study as such can be an effective means of identifying important variables and developing hypotheses about significant relationships. It is often necessary to conduct further studies using statistical methods, and sometimes a combination of both systems may prove to be the most effective approach.

Limitations of the case study method

Now that we have described the case study method and the various ways of using it, we can take a look at its limitations. They can be broken down as follows:

a. For the most part, case studies are more applicable to the social sciences than to the natural sciences. All the same, they are not totally unknown or out of place in the natural sciences. Forestry engineers, agronomists and other members of the agricultural sciences are only a few of the many types of researchers who have worked to develop their own case studies.

b. Case studies cannot replace many other types of analysis.

The complementary nature of case studies and statistical studies has already been mentioned. It would be meaningless to attempt to study a case drawn from a given universe whose major characteristics had not even been identified. This is why census, sampling, and survey techniques must be used. In addition, statistical methods enter into play for summarizing the results.

It may occasionally be helpful to study a single unit not considered "representative" of some more or less defined universe. It should be noted that some researchers have been overly optimistic, claiming they could select a single case to represent adequately a universe, or at least some stratum of the universe. Likewise, if an individual case accurately represents a universe in certain important aspects, it can rarely be shown to be representative in all areas.

This is why case studies cannot totally replace other methods of obtaining information about the universe under study. Neither can they eliminate statistical measures of central tendency, dispersion or regression for summarizing selected characteristics and relationships. Logical reasoning and other analytical activities are also used for this type of research. Even when a case study may be useful, it cannot act as a substitute for other analytical activities.

c. Case studies need relatively high levels of professional input compared with non-professional input.

Personnel conducting the analysis of case studies should have professional experience, be well trained and be capable of undertaking relatively complex, independent analyses. There is little opportunity for increasing professional output by using aides trained in limited capacities, such as interviewing and tabulating. University students can make valuable contributions and gain practical experience by participating in case studies. However, their work should be rigorously supervised and evaluated at all stages by more experienced personnel. Finally, these studies provide little opportunity for division of labor: the interviewer or observer who initiates the work should carry out the analysis and follow through by writing up the final report.

d. Once the promising hypotheses have been developed, the process of pursuing research with additional case studies is very difficult.

Although a series of these studies can be used for testing the hypothesis, the process is difficult; alternative methods are available and less costly. Statistical analysis can be very useful after the most important variables have been identified through case studies. While in some situations additional case studies may be the most effective method for testing hypotheses, at times problem-solvers can produce reasonable forecasts without waiting for the final stages of hypothesis testing.

e. In extension and technical assistance programs, farm planners cannot be expected to replace their planning efforts with the analysis of selected representative cases.

Farm management includes problem analysis, decision-making and accepting responsibility for the results. The decisions involve both subjective and objective factors of a situation characterized by certain unique aspects. The individual operator, by studying other businesses, can receive valuable guidance; but such a study cannot completely replace the planning effort.

Relationships between case studies and statistical studies

Problem-solvers are discovering that case studies are often key factors in identifying variables and developing plausible hypotheses. In this sense they are comparable to statistical studies, for they provide the means to test hypotheses against historical evidence. Although both case studies and statistical studies can be valuable in the search for solutions to problems, case studies have different objectives and deal with real facts about the units of a given universe.

Data collectors, like problem-solvers, concentrate on the characteristics or behavior of a certain given universe. These universes can generally be defined more specifically if they are stratified. An example could be twenty- to forty-cow dairy farms in the State of Rio de Janeiro on January 11, 1975. In any case, the researcher or analyst cannot study all the units of the universe directly, and must instead make a selection. The choices are: a case study, a statistical analysis, or a combination of the two.

If the statistical method is considered preferable, data must be gathered from individual units to help describe a limited number of characteristics of the universe or the relationships they share. For example, attention could be centered on herd size or dairy farm income. The number of variables under study can be considerably greater, and various techniques can be chosen for measuring either central tendencies or distribution characteristics.

A real-life study of individual cases is essential before greater efforts can go into studying the statistical relationships among the many variables of agricultural management problems. Important causal relationships can be determined only by examining the various facets of a particular case and using logical reasoning. As Salter[11] notes:

"Units of observation are always something to be treated with extreme care, especially in social science. Whatever the scientist may do in wielding the scalpel to expose the behavior of social units, he must not destroy their functional systems, which consist of relevant attributes as they actually are patterned within each observed case. If his research procedures involve the manipulation of attributes within each unit of observation, the researcher will be ruining his opportunity to observe the very thing he seeks to understand. This danger constitutes the greatest weakness of the predominant techniques for arranging evidence in rural social science research."

Past experience has shown the impact of informal case studies on statistical research. An in-depth familiarity with the operations of the actual units of a statistical universe has given rise to many hypotheses that could then be tested more rigorously through statistical processes. This suggests the potential value of systematic combinations of case studies and statistical studies.

SUMMARY

Information needed for analyzing and planning an agricultural enterprise can be obtained from primary and secondary sources. Primary sources include: direct observation of many facets of an enterprise, the memory of the campesino, and current records and accounting systems. Secondary sources could be: research findings published by experimental stations and government agencies, input and product price information provided by wholesale markets and other types of agencies, and data on climate and potential land use published by specialized agencies. These two types of data are complementary.

It is important to develop record-keeping and accounting systems suited to the size and needs of each enterprise. The approach to be taken for the analysis and planning of an existing business is different from that needed for a business created by agrarian reform and settlement programs in some countries.

The types of farm management research can be classified in various ways. Most concentrate on studying the enterprise as a whole and measuring its economic and social impact. Enterprises can also be studied in terms of their efficiency of resource use and its implications on the national level. Many studies have been made on production costs, and the various factors which affect the economic performance of an agricultural enterprise.

The users of agricultural management research findings include campesino farmers, agricultural researchers, extensionists, commercial enterprises, agricultural policy-makers and professors and students of the agricultural sciences.

This type of research has been assuming its own characteristics as it leans more toward problem-solving. Research direction-setting should take into account the interests of farmers, policy-makers and researchers themselves. If it is to serve as a source of data for identifying and classifying problems, it must be based on a complete understanding of the production and agricultural marketing processes as well as changes in resource availability, prices, technology and institutions.

Farm management researchers, like other social scientists, should learn to work fast with limited resources and make predictions to help resolve complex problems of a transitory nature. One crucial element of the task is developing feasible hypotheses for specific situations, useful for making predictions and describing past behavior. This requires efforts to understand causal relationships under local, specific conditions.

Research alternatives include logical reasoning, statistical study and case studies. Logical reasoning organizes real data accumulated in case studies and through statistical analysis. Case studies frequently provide the "spark" to kindle both the logical reasoning process and the use of statistical methods for testing hypotheses empirically.

QUESTIONS

1. Describe and compare the types and sources of data for existing enterprises and new enterprises.

2. Briefly describe the purposes of farm records.

3. What factors should be taken into account when selecting a system of accounting for an agricultural enterprise?

4. What characteristics are needed in the records for a business raising: 1) livestock and 2) cotton?

5. Prepare record sheets for the above businesses.

6. Prepare a list of the types of farm management studies that have been conducted on enterprises in your area of work or study.

7. Briefly describe research oriented toward problem-solving.

8. Of what value are the concerns of campesinos and policy-makers in the research process?

9. Compare the statistical method to the case study method. Explain the advantages and disadvantages of each.

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CHAPTER 5

STANDARDS OF MEASUREMENT FOR ANALYZING THE AGRICULTURAL ENTERPRISE

In order to compare agricultural firms or groups of enterprises, it is necessary to have indices or measurements for comparison. In this chapter, we will discuss these measures, show how to calculate them and explain how they can be used for analyzing individual firms or groups of firms. We will also briefly discuss the factors affecting enterprise profitability.

FACTORS AFFECTING THE PROFITS OF AN AGRICULTURAL ENTERPRISE

PRICES

For the preparation of alternative management plans and for daily decision-making, price levels in the overall economy are at least as important as the particular price levels of goods produced by the farm. The overall price structure during the six months, one year or two years previous to the planning stage is, however, one of the most important factors in making production plans for the farm.

During inflationary periods, prices of agricultural products rise much more rapidly than prices of farmer purchases. Consequently, farmers' incomes may also rise. When the economic cycle drops off, prices of agricultural products decline much more rapidly than costs of production. Profits fall and farmers must try to keep production costs low (Beneke[1]).

Enterprise profits depend on the prices of goods in finished condition and ready for market, rather than on prices in effect when crops are planted or livestock is purchased for fattening.

Future prices for all agricultural products are affected by changes in the supply-demand relationship for specific products, and by general price trends.

Researchers and farmers must learn to estimate long-run price trends; only in this way can an agricultural firm be successfully managed and alternative plans properly prepared. Production should also be molded to fit cyclical price changes (Beneke[1]).

SELECTING AND COMBINING PRODUCTS OR PRODUCT LINES

Every farmer must decide what crops to plant and what types of livestock to raise. Certain decisions, such as planting systems, fertilizer use, livestock varieties, and similar factors, can be determined according to customary practices in the area and knowledge of scientific principles relevant to each special case. An understanding of the product-product, factor-product and factor-factor relationships and the principle of comparative advantage can also be a great help in the process of selecting and combining product lines.

The primary decisions on product lines are economic in nature and constitute one of the major problems of farm management. This selection depends not only on the size and type of farm and soil productivity, but also on the amount of labor available. Other important considerations are start-up costs, probable prices of the product when it is ready for sale, marketing facilites and other economic factors.

These factors should be considered and evaluated on a concrete basis, applying marginal analysis as discussed in Chapter 3 to compare the economic advantages and disadvantages of each alternative before a decision is made.

Combination of product lines

The firm's profits are not determined solely by high extra income derived from some special product. Total profit or loss for one year is the net income of the firm as a whole. Many farmers are not located in regions so favorable as to provide adequate profit from the production of a single, exclusive line. Land is not uniform throughout the farm; some areas are suitable for pasture lands, others for crops. Every farmer's goals must be to develop the optimal combination of products or product lines for earning the highest possible profits in terms of net income for every operating year. These profits depend on the four types of relationships mentioned above.

The ideal combination sustains the productivity of the soil and produces higher income. It requires complementary operations, to reduce costs or increase yields and, finally, supplementary products to improve resource use, increase income, and maintain productivity levels.

Additional administrative decisions for selecting ideal product lines (crops or types of livestock) should involve a broad knowledge of the products themselves as well as their relative intensity.

VOLUME OF BUSINESS

Physical size, measured in hectares, is one of the many factors which determine the volume of agricultural business. Other factors are: investments in buildings, machinery, equipment and other production inputs, and the quantity of labor needed for different farm activities. It is the combination of these factors that produces the different systems of cropping or land use.

For example, vegetables require large quantities of labor and fertilizers which, in turn, introduce high risks when combined with intensive systems. Intensive cropping is defined by comparatively large quantities of labor and capital (excluding land) per unit of land area.

Pasture and some grains, when not under irrigation, require less labor and are considered extensive crops. Extensive exploitation involves low labor and/or capital (excluding land) per unit of land area. The addition of one or more operations that make more efficient use of resources can increase the size or volume of business on limited land holdings.

For this reason, a relatively large agricultural enterprise can diversify itself into a series of small firms by combining various intensive crop and livestock activities (vertical development). Similarly, a large enterprise can have a relatively small level of business if it concentrates on extensive crops or if part of the farm lies unused.

To increase the volume of business or the size of the firm, various alternatives may be employed (horizontal development): 1) introducing new operations that make more efficient and intensive use of resources; 2) increasing land area by renting from another farm; and 3) buying more land.

Generally, large agricultural firms have more opportunities for increasing income, but when conditions become unfavorable, they stand to suffer the greatest losses.

According to Weitz[8] the advantages of a large-scale enterprise are:

- The manager and workers can specialize in a limited number of activities on a relatively broad scale, thus increasing productivity.

- Production lines can be chosen so as to optimize advantages of location (optimum use of land, water and climatic conditions).

- Mechanization in planting, harvesting and product classification can be maximized (if topographic, ecological, and meteorological conditions allow). This mechanization helps reduce per-unit production costs, improve product quality, and favor the establishment of standards and methods for product selection.

- Enterprises can improve themselves by adopting modern technology without the problem of land fragmentation or overpopulation of the farm.

– In view of the steady fall of transportation costs, now only a small portion of total production expenses, farm workers can live in neighboring towns. This averts the need for expensive lodging on the farm, all too often characterized by the shortage or poor organization of community services. Under certain circumstances, the system of allowing farm workers to live in town can counteract the disparities between the rural and urban areas.

In view of these advantage of large-scale operations, some countries have chosen to bypass old family traditions and other social considerations and adopt this type of agriculture.

CROP AND LIVESTOCK YIELDS

Production efficiency is determined by crop yields per unit of land surface area and by the rates of production of livestock on the farm, within certain limits established by current farming practices. Greater production efficiency can bring higher incomes. Total farmer income depends on the number of units produced and the price received per unit. The quantity of the product, in turn, depends first on the volume of business and second on yields, or the number of units produced by each productive unit.

Fixed costs include land, depreciation, planting, construction of stables for livestock, etc. As a result, high-yield farms have lower unit costs than low-yield farms because fixed and other constant costs are distributed among a greater number of units. In order to maintain production levels appropriate for the conditions of the firm, it is necessary to determine the most suitable operating methods. This requires an understanding of the factor-product relationship and, consequently, involves decisions on both physical and economic matters.

In general, the yield is subject to the limitations of farming practices, as discussed above. They include: 1) climate; 2) biological factors of production; 3) soil capacity; and 4) the law of variable proportions or diminishing returns.

MAKING EFFICIENT USE OF LABOR, MACHINERY AND EQUIPMENT

Agricultural labor efficiency has to do with the quantity and quality of human productive labor in the agricultural firm. High levels of labor efficiency generally mean higher income per unit of production.

The size of the firm is closely related to the efficiency of the use of labor, machinery and equipment. Both factors exercise certain influences on income. If the volume of business is reasonable, better use can generally be made of these resources on the farm. This does not mean that size determines the efficiency of resource use; efficiency stems from certain specific causes and is not a primary factor affecting income. Improved use of labor and machinery is not a simple consequence of size.

MARKETING PRACTICES

On closed-economy or subsistence farms, marketing practices are of little importance, since transactions are either minimal or nonexistent. Nevertheless, all farmers are engaged in agricultural businesses, for they all work for economic goals: producing for sale, for family use, or both.

The farmer is a seller and a buyer; as such, farmers are confronted with a two-way problem. They must adapt their production lines to products with a market demand, and they must realize that marketing practices will undergo continuous change with the introduction of improvements in the production and marketing processes. All these factors influence the prices received for products. Finally, farmers must decide which marketing functions or services to exercise themselves, which to conduct in cooperation with their neighbors, either through cooperative associations or guilds, and which tasks should be eliminated altogether or left in the hands of private institutions or the government.

OTHER FACTORS AFFECTING INCOME

Farmer incomes may be subject to many other types of influences which vary according to operational efficiency and other management factors. These include: farm layout; economic use of animal labor; the age and educational level of the farmer; land tenure status; and land quality.

Some of these elements are interrelated with the factors of income variation. However, some have a direct bearing on farm income independently of any connection with other factors.

Farmers often give more attention to some given factor of the operation than to others. This would produce a high degree of efficiency in the use of that factor, but the year-end economic result could be lower income.

In short, year-end income depends more on the proper use of all the farm's factors than on the improved use of several. It is important to apply marginal analysis to determine the efficiency of resource use.

MEASURING PHYSICAL OUTPUT*

There are various ways of measuring and calculating the physical and economic output of the agricultural firm. The most appropriate method must be chosen on the basis of several factors, including the purpose of the analysis, local farming conditions and the availability of needed information. It is important for the measures and methods used for calculations in any research or study to be clearly defined.

The principal standards of measurement are:

Total land surface or acreage. This measurement includes all land worked as a unit, whether owned or rented, in contiguous or separate plots. It is a useful measure because of the variation between firms in terms of soil quality or land use intensity. It can be used to compare enterprises whose soil, climate and market conditions are similar.

Crop acreage area. This measurement is used for comparing farms raising crops of similar intensity and which place little importance on livestock.

Number of animals. Head of sheep, cattle, chickens and other animals is a good measure of size for enterprises specializing in one type of livestock and growing crops for family consumption but not for sale.

Capital investment. This is a useful measure for comparing different types of farms in the same region. It includes the average total investment at current market value of both the owner and the renter at the beginning and end of the agricultural year.

Number of farm workers. This measurement is useful for comparing either farms in different regions or different types of farms in the same region. Since labor efficiency varies, the same number of people can produce varying volumes of business.

Total man-days. This is a good measure of size. It represents the amount of productive work that goes into tending the farm's crops and livestock. Total man-days are calculated by adding the results of the following equations: the number of units of production (hectares of each crop, number of head of cattle) times the average number of man-days normally needed to complete these activities in the region under consideration.

(*) The methods of classifying and defining the standards of measurement presented in this book were developed by specialists of the Inter-American Institute of Agricultural Sciences through their courses and research on farm management. However, the author has made slight modifications.

The typical averages for man-days will vary from place to place and also across time in the same place. Generally, they represent a summary of the many standardized records kept by farmers participating in cooperative programs with universities, experimental stations and government organizations. The man-day —which is equal to nine hours of productive human labor— is a unit of labor and should not be confused with the total worker-days count of a business, which is a measure of size.*

Total gross farm income. This is the best measure of firm size, as it measures volume of production. However, it is difficult to compute when there are a large number of firms in a given region.

Total traction. This is generally a very useful measurement. It is calculated by totalling units of traction.

PRODUCTION YIELDS

Harvested weight per land unit. This measure is for crops and is commonly expressed in kilograms or quintals per hectare.

Quantity obtained per head. This is the accepted way of expressing production of meat, milk, wool, etc.

Quantity of livestock products per hectare. This measure is used mostly by firms specializing in the extensive production of sheep and cattle; it is expressed in kilograms of wool per hectare, liters of milk per hectare, or kilograms of meat per hectare. It correlates animal yields to forrage yields.

Animal load. This measures the productivity of grazing land and is expressed in terms of animal units per hectare. An animal unit is the ratio between feed consumed by the animal and the average consumption of a normal adult animal.

Birth and death rates. This measure is commonly expressed in percentages. The birth rate, or procreation, refers to the number of brood animals; the growth rate is determined by dividing the number of births by the number of adult stock.

Crop yield index. This measure is a comparison of the yield of the most important crops on the farm to the average yield for the region. The index cannot be calculated, therefore, unless the average or

(*) Labor legislation in some countries stipulates only eight hours of productive work. However, more than eight hours is more common.

standard for the area under study is available. The yield for each individual crop (Farm A in Table 5.1) is divided by the average yield for the region and multiplied by 100, which gives the simple yield index; this index is then weighted through multiplication by the number of hectares harvested. The weighted indices for each crop can thus be added together and the total is divided by the total number of hectares under cultivation, which gives the crop yield index for the farm.

TABLE 5.1. Calculation of the crop yield index—Hypothetical data. (Source: based on Yang[9])

Crop	Standard Average Yield (kg/ha)	Yield Farm "A" (kg/ha)	Hectares Harvested on Farm "A"	Simple Index Farm "A" (Ave. yield x 100) Col. 3 x Col. 2 x 100	Weighted Index (Simple Index x Hectares) Col. 5 x Col. 4
1	2	3	4	5	6
Corn	1,200	2,000	3	166	498
Potatoes	7,000	10,000	2	142	284
Wheat	1,400	600	1	42	42
TOTAL	–	–	6	–	824

$$\text{Crop yield index} = \frac{824}{6} = 137\% \text{ for Farm "A".}$$

This means that the farm yield was 37% higher than the regional average.

UNITS OF LABOR

a. **Productive man-work unit.** This is the amount of productive human labor completed in eight hours. Time spent maintaining fences, roads, buildings, canals, saddle horses, draft animals, recreation parks and other activities which are not directly productive is distributed among productive man-work units.

b. **Man-equivalent.** A man-equivalent is equal to one year of full employment for one worker. It is also known as a man-year. It is equal to 300 productive man-days and is calculated as follows: an estimate is made of the number of months (the average number of days per month if a complete month was not worked) the campesino, family members, and other permanent laborers worked on the farm during one year. Work is expressed in man-equivalents according to the relative work capacity of the laborer. For example, a day of labor by a woman is equal to one man-day. A child's workday is equal to 0.75 man-days.* These equivalents are multiplied by the number of months worked and the products are added together to give total man-months on the farm; this is divided by 12 months, which gives the man-equivalent.

c. **Available labor force.** This represents the total labor available to the agricultural firm for productive work. It is measured in man-equivalents and is calculated on the assumption that each adult worker is available 300 man-days per year. All males and females over 14 years of age are considered full-time laborers.

d. **Total wages paid.** This also includes an estimate of unpaid family labor. Although the total is easy to calculate, there is the obvious problem of pay scale variations from one campesino to another.

UNITS OF EQUIPMENT

Units of traction. This represents non-human labor on the agricultural firm. It is generally calculated by adding the following elements of traction:

- number of tractors multiplied by 6 (for each 30HP unit);
- number of work horses or mules;
- number of buffaloes multiplied by 0.9;
- number of oxen multiplied by 0.5.

Total HP (horsepower).

Value of existing machinery.

Machinery as a proportion of total investment.

(*) Values vary according to the region. This data should be calculated for each region or zone, as it depends on factors such as type of task, age of child, etc.

TABLE No. 5.2. Example of calculation of man-equivalents.

No. of workers	Type of workers	Man-equivalents	Months worked	Total months
1	2	3	4	5
1	Man	1	12	12
2	Permanent workers	2	7	14
1	Woman	1	3	3
1	child (less than 12 years old)	0.75	4	3
TOTAL				32

$$\frac{\text{Total months}}{\text{months in year}} = \frac{32}{12} = 2.6 \text{ man-equivalents}$$

(*) The values used here have been suggested by Yang[9].

MEASURES OF LABOR EFFICIENCY

While units of labor measure the quantity of work, units of efficiency measure the results of work. These two measures must not be confused.

Day Labor. This measures how much work the laborers actually have to do.

UNITS OF PRODUCTION HANDLED PER MAN-UNIT OF INPUT

Examples: milk cows per man-equivalent;
chickens per man-equivalent;
hectares of crop per 1 000 monetary units of day wages;
animal units managed per worker-year

UNITS OF PHYSICAL PRODUCTION SOLD PER LABOR INPUT

Examples: liters of milk per man-equivalent;
dozens of eggs per man-day;
kilogram of wheat per 1 000 monetary units of day wages.

This group of units is rarely used, since animal and plant production yields have generally been analyzed elsewhere.

Income or receipts per unit of labor. Example: gross income or receipts per worker-day.

MEASURES OF EQUIPMENT AND MACHINERY EFFICIENCY

Yield per hour. The quantity produced per unit of time is a good measure of efficiency for certain machines such as threshers, shellers, combines and mills.

Units of traction per 100 hectares cultivated.
Tractors per 100 hectares cultivated.
Horsepower (HP) per 100 hectares cultivated.

Hectares covered per man-day. This measure is used to determine the efficiency of equipment in certain operations, such as plowing, harrowing and reaping, in which the yield is calculated by relating the size of the field to the surface velocity of the machine.

Revenue per 1 000 monetary units of investment in equipment.

UNITS BASED ON COMBINATIONS OF PRODUCT LINES

Number of product lines. This measure is difficult to use when income differs considerably among the different operations.

Percentage of income or revenue from crops or livestock. This is useful for simple studies.

Number of product lines providing more than 10 percent of gross farm output. This judges the importance of the operations on the basis of the land surface area they involve and the value of their production.

Income from the major product line. This is very useful for specialized farms.

Monthly labor distribution. This measure is calculated for each product line and for the entire business and is expressed as a percentage of man-days.

Percentage of worker-days used per crop or type of livestock.

MEASURING ECONOMIC PERFORMANCE

There are two basic approaches to measuring economic performance:

RESIDUAL MEASURES

This reveals how much extra money is generated by the production process to be used for remunerating one or more resources. The principal measures are:

Total enterprise income. This is the quantity of money and goods the producer sets aside to pay for land, capital and the labor of the farmer and the family. It is calculated by subtracting total expenditures from gross income (see Figure 36).

Net production. This is the residual of gross income to be used for remunerating the factors of production: land, labor and capital. It is calculated by subtracting expenditures (minus salaries) from gross income.

Net earning on capital investment. This is the return to the firm's capital. It is calculated by subtracting labor expenditures (wages, benefits, non-wage family labor and an estimate of the farmer's labor) from net production.

Labor earnings. This is the residual held out to remunerate labor. It is calculated by subtracting total capital services (interest plus real or assumed rental) from net production.

Family income. This is residual income for remunerating family labor. It is calculated by subtracting wages from labor earnings.

Farmer income. This is the residual for paying for the physical labor and management activities of the farmer. It is calculated by subtracting unpaid family labor from family income.

In order to determine unpaid family labor, determine the number of man-days of family members, according to the pay scale for hired workers. It should be weighted by age and sex.

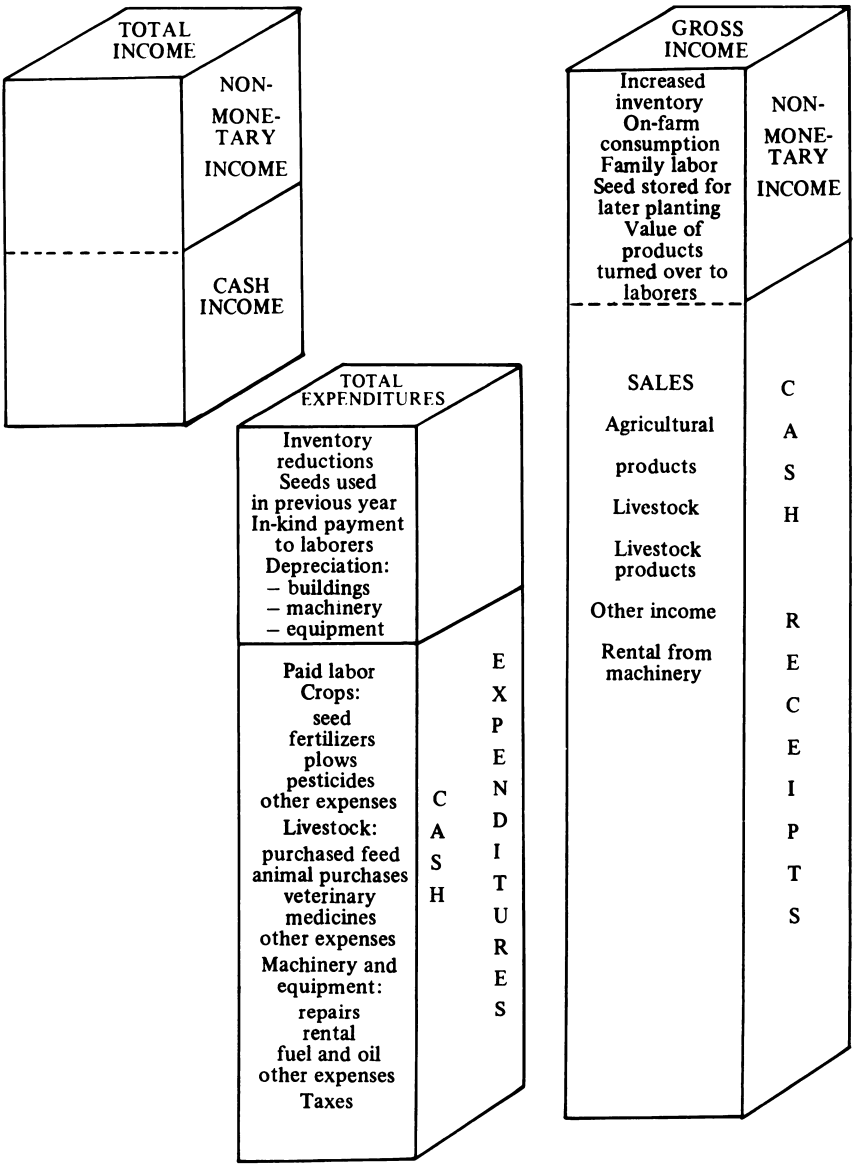

Fig. 36. Structure of total income, total expenditures and cash income in the agricultural enterprise.

Liquid profit. This is the residual left from net production after the factors of production are paid. It is calculated by subtracting the value of the farmer's physical labor from farmer income.

Liquid profit, measured under similar conditions, reflects the intellectual efforts or managerial abilities of the farmer.

Cash income. This is the quantity of cash generated by the firm and available to the family for living expenses, savings, taxes and investment.

MEASURES OF PROPORTIONALITY OR EFFICIENCY

This compares economic performance with inputs for any resource or set of resources. The most common measures are:

Income or gross revenue per man-day. Gross revenue is the final total production for an agricultural year.

Income or gross revenue per hectare.

Total income of the firm per man-equivalent. Man-equivalent is equal to the labor of one worker for 300 workdays.

Profit. This is the capital income as a percentage of average total capital.

MEASURES FOR FINANCIAL ANALYSIS

In addition to the current levels of productive efficiency in the agricultural enterprise, it is helpful to know its financial condition. This is useful for conducting evaluations in response to credit requests. It can be done with the balance sheet using the following indicators, according to Kaldman Encinas, as quoted by Gastal[4]. These indices can be used in firms which keep complete records and accounting systems such as cooperatives and some of the associative firms mentioned in Chapter 1.

General solvency (GS). This indicates the firm's capacity to guarantee its debts, or total liabilities (TL), on the basis of its possessions or total assets (TA). The minimum acceptable value in this analysis is 2.0.

$$GS = \frac{TA}{TL}$$

Immediate solvency (IS) or the acid test. This indicates the firm's capacity to cover immediate current liabilities (CL) in the short term with liquid assets (LA). The minimum acceptable value is 1.0.

$$IS = \frac{LA}{CL}$$

Liquidity (L) or ratio of working capital. This reflects the firm's ability to cover current liabilities (CL) with current assets (CA). The minimum value desirable is 2.0.

$$L = \frac{CA}{CL}$$

Physical guarantee (PG). This gives the firm's capacity to guarantee medium and long-term fixed liabilities (FL) with fixed assets (FA). The minimum value desirable is 2.0.

$$PG = \frac{FA}{FL}$$

Financial independence (FI). This gives items owned by the firm, or net worth (NW), as a percentage of total goods used by the firm, or net worth plus total liabilities (TL). The minimum desirable value is 50 percent.

$$FI = \frac{NW \times 100}{NW + TL}$$

The maximum theoretical value of FI is 100 when TL equals zero. If FI is zero, the firm is out of capital because NW is also zero. When FI has a negative value, the firm is bankrupt because NW is negative and total liabilities are greater than total assets, with TA = TL + NW. When FI = 50%, NW = TL and total liabilities can be covered by net worth.

SUMMARY

Certain measurements must be used to compare two or more firms or to analyze an individual enterprise. These measures are grouped into three categories: physical output, economic performance and financial condition.

The first group contains:

1. **Measures of size or volume of business,** including: total land surface, or acreage on the farm; crop acreage area; number of animals; capital investment; number of farm laborers; total productive man-work units; total farm income; and total traction.

2. **Measures of production yields,** including: harvested weight per unit of land; production levels per head; volume of livestock products per hectare; animal load; birth and death rates; and crop yield index.

3. **Measures of labor, or** productive man-work units; man-equivalents; available labor force; and total wages paid.

4. **Units of equipment,** which include: units of traction (number of tractors multiplied by 6 for each 30 HP; number of work horses or mules; number of buffaloes multiplied by 0.9; number of oxen multiplied by 0.5); total HP; amount of machinery on the farm; and proportion of total investment in machinery.

5. **Measures of labor efficiency** include: man-days; production activities that can be handled per unit of labor (cows per workday or hectares cultivated per 1,000 monetary units of day wages); physical production per man-equivalent (liters of milk per man-equivalent or dozens of eggs per worker-day); and net farm output per man-equivalent (total income per worker-day).

6. **Measures of equipment and machinery efficiency,** which include yield per hour and units of traction per 100 hectares cultivated.

7. **Measures combining product lines,** which include: number of product lines; percentage of income provided by livestock or crops; number of products which contribute more than 10 percent of gross farm income; income from the major product line; monthly labor distribution across product lines; and percentage of worker-days used per crop or type of livestock.

Enterprise profits can be influenced by a series of factors such as: prices; selection and combination of product lines; size or volume of business; livestock and crop yields; marketing practices; efficiency in the use of labor, machinery and equipment; farm layout; economic use of animal traction; age and education of the farmer; land tenure status; and quality of the land.

These factors directly and indirectly affect enterprise profits. Year-end income depends more on the efficient use of all factors than on the best use of only one factor. Marginal analysis is important for determining the efficiency of the use of these factors.

There are two ways to measure the economic performance:

1. **The residual method** is based on the principle that after total expenses are subtracted from gross income, any remaining funds are for the remuneration of one or various resources in the productive process. The principal measures are: total enterprise income; net production; net earnings on capital investment; farm labor earnings; family income; farmer income; liquid profit; and cash income.

2. The second group of measures is the **proportionality method** whereby total farm earnings are distributed among the production factors. Some of these measures are: income or gross revenue per man-day; income or gross revenue per hectare; and total farm income per man-equivalent.

In order to understand the financial condition of the firm, the following indicators can be used:

1. General solvency; 2. immediate solvency; 3. liquidity; 4. physical guarantee; and 5. financial independence.

QUESTIONS

1. Briefly analyze how prices can affect economic performance.
2. Compare the advantages and disadvantages of large-scale firms and family-type firms.
3. Indicate three measures of size or volume of business and explain when each should be used.
4. What types of relationships or factors should be taken into account in the selection and combination of product lines?
5. List two measures of product line combinations. Explain the advantages and disadvantages of each.
6. How do livestock and crop yields affect economic performance? Briefly describe.
7. How does efficient use of labor and equipment affect economic performance?
8. How is labor efficiency measured? Indicate the advantages and disadvantages of these measures.

9. Net income, farmer earnings and labor earnings are residual measures of economic performance. Define them in your own words and give examples.

10. How do marketing practices affect economic performance?

11. List and describe three indices for conducting a financial analysis of the firm. Explain how they are used and what they mean.

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CHAPTER 6

PROCEDURES FOR ANALYZING AND PLANNING THE AGRICULTURAL ENTERPRISE

The need to plan and reorganize farm enterprises can emerge from agrarian reform programs, campesino settlement plans, supervised credit programs, colonization plans or the final phases of agricultural sector planning projects as a part of overall planning. In any activity of this type, it is necessary to delimit and evaluate various alternative management programs, taking into account the quantity and quality of available resources, their production potential and the ecological conditions under which agricultural enterprises will be operating in the future.

There are several methods for planning and analyzing agricultural enterprises. Planning can be done through the budgetary approach, simplified programming or line programming, while the analysis of the enterprise can be approached through comparative budgets or marginal analysis. Marginal analysis was discussed in Chapter 3.

Of these three planning methods, budgeting and simplified programming have been singled out for more detailed treatment in this chapter. These two methods are considered the most appropriate for the conditions and situations of the agricultural enterprises in Latin America. This is especially true in view of the availability of information from records or accounting systems. Although linear programming is a widely accepted method, we will present only a summary of its characteristics, possible applications and limitations.

The term "budget" refers to any means of controlling expenses according to established guidelines. However, as it is generally used in agricultural management, the term implies only a tentative estimate of revenue, expenditures and net income, useful in management plans for a future period of time. But agricultural management frequently emphasizes the outcome of various alternative plans; therefore, the results of these plans must be evaluated through comparative budget studies.

Simplified programming, also known as systematic budgeting, is a tool used for planning the agricultural enterprise, especially in determining the combination of crop and/or livestock products which will maximize net income for a given quantity of available resources. The distribution of resources among various alternative production lines (income maximization), the minimization of production costs for a given output, or the optimum use of resources over time are standard problems which can be solved through linear programming. The optimum level of input can also be determined with this system, although marginal analysis is preferred for this type of problem.

COMPARATIVE BUDGETING

Comparative budgeting is a technique for evaluating alternatives during the fourth and final phase of planning. Naturally, this method is useless unless two or more alternatives have been selected for analysis. At the same time, there is no point in drawing up comparative budgets if no action is going to be taken on the final decision.

PLANNING BY SUCCESSIVE APPROXIMATION

The planning of an agricultural enterprise could be illustrated as the mathematical process of solving a series of simultaneous equations. Some would represent the possibilities for transformation under existing technology, while others would symbolize limitations imposed by available quantities of essential resources.

When plans are drawn up for new enterprises, the illustration of anticipated outcome could include relevant restrictions or limitations. For example, recent studies in the United States have sought to determine the minimum size at which a business can produce a net income of "X" dollars for the operator and the farm family (Brewster[1]). This type of objective can also be stated in terms of employment, or the number of hectares necessary to provide full-time work to the farmer and the farm family living on a development project. This type of situation commonly occurs in settlement or resettlement programs (Franklin[5]).

The problem is to determine the most suitable size for the agricultural firm, or the most beneficial volume of production for the business. In a settlement project, the size depends on the number of families to be settled, as well as the quantity and quality of available resources and their possible uses. This implies the need for numerous analyses to be undertaken by management specialists prior to the final determination of the limits of farm size. It should also be understood that size can change over the years. Generally, technological progress tends to increase the size of the farms over time, unless large numbers of farm families remain in agricultural work.

Although planning processes can be compared to solving simultaneous equations, strictly mathematical methods sometimes provide less than optimum results. On the other hand, a process of successive approximations with simple arithmetic operations is often preferable.

When a business is reorganized, a series of small changes in the existing plan can be examined successively, and the result generally is the emergence of new possibilities which should be explored. In any case the probable outcome of drastic changes can be estimated by making exaggerated assumptions about the farmer's administrative abilities; in such a case, the analysis should not be viewed as rigorously mathematical. It should also be noted that the transformation function is seldom continuous, and for this reason, a mathematical approach may be difficult and misleading. In view of such problems, mathematical planning methods are generally less efficient than expected. Another advantage of the technique of successive approximations is that it can be applied by a capable farmer or analyst using only paper and pencil.

The first step in planning

The crucial step in applying the technique of successive approximations is to identify and select the most promising alternatives for the test of comparative budgeting. This step is as important for new farms as for the reorganization of existing enterprises. In both cases the comparative budget method can be used for evaluating alternatives.

In the literature on planning agricultural firms, many writers have tried to designate a series of steps which should be followed in a given sequence for an orderly planning procedure. Some suggest that this process should begin with a resource inventory; a few even believe that a look at the physical capacity of the farm's natural resources will reveal the best plan. Others strongly lean toward considering the objectives and goals of the farm family, assuming that any given objective can be reached through adequate use of available resources. However, the goals must often reflect some kind of trade-off between ends and means. Thus, it would be equally appropriate to suggest that the goals cannot be established until the possible alternatives have been examined.

In some cases, promising alternatives emerge immediately and appear to be worth studying and testing; in others, a list of possibilities, similar to Form 1, can help stimulate the farmer's and the farm planner's imaginations. Once certain alternatives have been partially identified, the factors listed in Form 2 can be studied in order to define each alternative more clearly.

In view of all this, it is unlikely that a specific sequence of steps can prove to be an ideal technique for all situations. The most essential qualities for any planner include an active imagination moderated by a familiarity with the types of organizations that have been most successful under more or less similar conditions.

Developing meaningful comparisons

A comparative analysis of various alternative plans is, therefore, the major objective of every planning process. The economic basis for such comparisons can be developed with the use of Form 3, although many non-monetary considerations should also be taken into account. The essence of the economic planning process for either new or already existing units is to test out the various budgets, as shown in Form 3. The subsequent stages of the process strive for all these objectives.

The structure of the model presented in Form 3 varies according to the nature of the major alternatives in each area. The list of products and inputs will vary from one zone to another or from one type to another. The number of alternative plans to be considered can also change for each case; at times the comparison covers only two plans, while in other cases, a dozen or more can be compared. However it is impractical to try to juggle too many plans simultaneously.

Form No. 1. List of managerial changes to be considered.

General nature of change	Specific means for achieving change	What I plan to do	Will it be effective?
1. Increase quantity and value of commercial crops	a. Select high-value crops; b. Plant improved varieties; c. Use more fertilizers; d. Control pests and diseases; e. Search for new markets; f. ________		
2. Produce and provide more high-quality forage	a. Change rotation; b. Increase lime and fertilizers; c. Purchase less concentrates; d. Increase silo capacity; e. Increase per-animal milk production; f. Increase livestock; g. ________		
3. Produce more milk per cow	a. Control diseases; b. Use selection and cross breeding; c. Improve pasturage; d. Use silage or hay; e. Use forage and concentrates; f. Keep better records; g. ________		

Form 1. (Cont.)

4. Increase number of piglets per litter	a. Improve hygiene; b. Establish a permanent weaning house; c. Acquire equipment for weaning house; d. Improve pig feed; e. ________________
5. Increase output of labor	a. Specialize; b. Use equipment prudently; c. Increase yields; d. Eliminate unnecessary worker-days; e. ________________
6. Seek source of additional income	Look into: a. Secundary enterprises; b. Processing and direct sales; c. Off-farm employment; d. Custom work; e. ________________
7. Reduce expenses	a. Plan feeding programs for increased production, rather than for appearances; b. Resist temptation to spend; c. Purchase wisely (seek discounts); d. ________________
8. Reorganize milking operation	a. Use a storage tank; b. Establish a milking room; c. Expand herds; d. Change crops; e. ________________
9. Achieve self-sufficiency in corn	a. Increase planting; b. Harvest for storage; c. Increase yields; d. Automate processing; e. ________________
10. Include family in business	a. Introduce youth projects; b. Establish family companies; c. Rent; d. Transfer the farm; e. ________________

Form No. 2. Identifying alternatives to be considered in planning a farm or household.

ITEM	Alternative I	Alternative II	Alternative III
General nature of alternative			
Specific nature of implied changes			
If these changes are made, how will they affect:			
Crop area and rotation?			
Fertilization methods?			
Other cropping methods?			
Number of animals?			
Feeding methods?			
Other stock handling methods?			
Building use?			
Machinery use?			
Labor use?			
Total investments?			
Credit use?			
Food produced for home consumption?			
Food purchases?			
Family housing?			
Household appliances and furniture?			
Free time and recreational activities?			
Other?			

Form No. 3. Summary of comparative budgets under alternative plans for farm ______________________

ITEM	PLAN 19 __	BENCHMARK PLAN	PLAN II	PLAN III
PRINCIPAL FEATURES OF EACH PLAN				
GROSS REVENUE: Crops				
Livestock				
Milk				
Eggs				
Chickens				
Machinery rental				
Land rental				
TOTAL GROSS REVENUE				
EXPENDITURES: Permanent Laborers				
Temporary Laborers				
Social benefits				
Seed				

Form 3. (Cont.)

ITEM	PLAN 19—	BENCHMARK PLAN	PLAN II	PLAN III
Fertilizer and lime				
Feed				
Veterinarian and drugs				
Stock purchases				
Shipping charges				
Taxes				
Repairs				
Ongoing replacements				
One-time replacements				
Current interest				
Additional interest				
TOTAL EXPENDITURES				
NET INCOME				

It often occurs that one of the future alternatives for existing farms is to continue without making sizeable changes. This alternative can serve as a point of reference or a basis of comparison for other plans that involve changes.

This benchmark plan should represent future events which will occur with the continuation of activities of past years. When crops, herd size, yield and methods have not varied greatly from one year to another, the development of a benchmark plan, based on historical data, may be very easy. However, practically all agricultural firms make changes in their physical and economic activities. In many cases, therefore, the benchmark plan will not accurately reflect the real activities of any specific year, while in others, such a plan may be almost totally meaningless. Finally, in the planning for a completely new farm, historical data are simply not available for developing a benchmark plan.

In Form 3 each alternative plan is described by a series of monetary values for revenue, expenditures, and net income. It should be noted that the expenditure and revenue items are determined by multiplying a quantity by a price. If the comparison of alternatives is to have any value, all expenditure and revenue items must be calculated with the same price tables, reflecting prices which are expected in the future. This is applicable to the benchmark plan as well as to the alternatives. Therefore, the revenue, expenditures and net income figures of the benchmark plan may differ considerably from past figures, even though the quantities may be based on historical data. This is why the development of a benchmark plan implies much more than merely accepting the historical records.

The income figure (see Chapter 5) in Form 3 should show the profit that the producer and the farm family will earn with the use of a fixed quantity of available resources. Generally, this group of resources includes:

- the farmer's labor;
- unpaid family labor;
- fixed capital equal to the total value of the farmer's land, buildings, machinery and animals;
- the farmer's administrative activities.

Because the net income figure represents combined earnings on these family resources, the individual items need not be singled out and assigned arbitrary values. Since the purpose of planning is to determine how to increase income by combining the resources of the farmer and the family, no value should be assigned to family labor or to the producer's own capital. Therefore, most gross income or expenditure entries represent cash transactions expected under a given plan of operations.

In a comparative analysis, any variations that may occur in the combination of resources used by the agricultural enterprise must be handled very carefully. For example, if Plan III will reduce labor enough for the operator to devote one-third of his time to off-farm work, the change should be explicitly recorded in some manner. The simplest procedure in such a case may be to add the income from off-farm work to the Plan III gross income figure, so that net income under this plan reflects earnings on the same resources as those considered under Plan II. For the same reason, transportation costs from the farm to the off-farm employment site should be included as an expenditure of Plan III.

However, it may happen that the savings in worker-hours under Plan III is used to provide the producer with free time. This benefit should be included in the analysis but should not be assigned a monetary value or be listed as real profit under gross income. It is much more accurate to regard this benefit as a non-monetary advantage of the plan. These are two different types of profit and should be evaluated separately.

The opposite case may arise when an increase in the volume of farm sales requires the use of working time previously engaged in off-farm activities. In this case off-farm income would be included in the figures for the benchmark plan. When there is no change in off-farm activities, the resulting revenue can be included or excluded without affecting the comparison.

Almost all the revenue and expenditure entries listed in Form 3 are calculated by multiplying a physical quantity by a price. Therefore, some type of work sheet should be used for calculating the figures. When forage is grown on the farm for cattle feed, it can be very helpful to have charts or diagrams showing the differences between the quantities purchased from outside and the quantities grown on the farm. The same problems occur in calculating seed and fertilizer needs.

Form 4 has been successfully used in making these calculations for various types of specialized and diversified agricultural enterprises in regions of Colombia and Brazil. Similar tables could be developed for Brazilian coffee enterprises or Argentine cattle ranches, but each should be carefully adapted to the calculation needs for the specific type of business. The table shown here was designed for a farm on which forage and grains are produced for feeding cattle on the farm. The two types of feed are measured in "corn equivalents" and "hay equivalents" in the columns on crop production and feed consumption. Crop and cattle sales are calculated by determining total production, subtracting the quantity used on the farm, and multiplying by prices. Expenses incurred for fertilizers, seed, cattle and feed purchases are also determined with quantity and price data. The application of nutrients (nitrogen, phosphorus and potassium) to crops can likewise be calculated in terms of units per hectare cultivated. Some of these calculations are suitable for Colombian coffee farms, while others are irrelevant. Generally, it may be necessary for coffee farms to use a special form for calculating labor needs at different times of the year.

The use of partial budgeting

When simple administrative changes are under consideration, it is helpful to calculate changes in revenues and expenditures. Thus, for a given change in Plan B it is necessary to consider only those revenue and expenditure items which are expected to increase or decrease, and then calcula , expected changes in net income. This calculation is sometimes known as partial budgeting (Form 5), as distinguished from "total budgeting."

Form No. 4 Crop and livestock plan.

Farm: ______________________ Plan: ______________________

Crop	Hectares	Yield	Production	% pertaining to farmer	Used on Farm			Sales			Fertilizers		N P$_2$O$_5$ K$_2$O
					Seeds and consump.	Concentrates	Forage	Quantity	Price	Total value	Type	Rate	
Total area cultivated													
Permanent Pasturage													
Forests													
Other lands													
Total area													

Form 4 (Cont.) Crop and livestock plan

Farm: ______________________ Plan: ______________________

Livestock	No.	Yield	Total production	Quantity used on farm	Concentrates supplied		Forage supplied		Sales			Special Purchases			
					Per head	Total	Per head	Total	Quantity	Price	Total value	Item	Quantity	Price	Total value
Milk cows												Fertilizers			
												Seed			
Bulls															
Calves born during year												Animals			
												Feed			

Form No. 5. How to calculate changes in income that will result from specific changes in the management of the agricultural enterprise.

Name of farm ______________________________

I. Projected changes in operations ______________________________

____

____

II. Expected changes in net income:

1. Additional income

______________________________ $ ______________

______________________________ ______________

2. Reductions in income

______________________________ $ ______________

______________________________ ______________

Net increase in income $ ______________

3. Additional expenditures

______________________________ $ ______________

______________________________ ______________

4. Reductions in expenditures

______________________________ $ ______________

______________________________ ______________

Net increase in expenditures $ ______________

INCREASE IN NET INCOME $ ______________

TIME PERIODS FOR COMPARATIVE BUDGETS

Special attention should be paid to the time periods used for comparative budgets, as some decisions are important only in the very short term, while others have a long-run impact. Some of these variations fall into the following categories:

a. Decisions which affect activities and output in the very short run, such as:

   -- daily decisions concerning the use of regular workers for feeding and planting;

   – decisions on input purchases for immediate use, purchase of gasoline, hiring temporary workers.

b. Decisions which have a major effect on activities and output over a time period ranging from several weeks to a year, such as:

   – crops to be planted next year;

   – the use of fertilizers;

   – feeding rates for cattle;

c. Decisions which affect the firm over the long run, such as:

   – plans for crop rotation and herd size;

   – plans for labor and machinery use;

   – plans for land improvements, water supply, construction, etc.

All these decisions are interrelated, but the third category should be considered separately due to its long-run effects on the enterprise and because, generally, these decisions involve investments which should be recovered through increases in future income over many years.

SOME PROBLEMS IN MAKING COMPARISONS

When comparisons are made, it is indispensable to define very clearly the items to be compared, the basis of comparison and the period under consideration. Some of the most common problems involve distinguishing between operating expenses and capital investment.

Operating expenses versus capital investment

In accounting practice, distinctions are generally made between operating expenses and expenditures incurred for capital investment.

Generally, disbursements for capital investment involve items which provide a service for the enterprise for a period of time greater than one year, while operating expenses cover items consumed in the current operation of the business. The distinction is not always very clear; fertilizer, for example, can contribute to improving the soil, although its primary purpose is to increase the current harvest. Generally, seeds, fertilizers, animal feed, materials for repairs, packing materials, insurance, taxes and other such items are considered operating expenses, while new buildings, heavy equipment, breed or production stock and land improvements are considered capital investments.

Capital investments in comparative budgets

The purpose of drawing up comparative budgets is to compare the outcome of various alternative plans for managing a company or private operation over a fixed future period of time. In agricultural management, interest is often concentrated on the outcome of various alternative plans whose benefits will be felt for at least 5 or 10 years. Thus, it is very important to account carefully for capital disbursements in making budgetary comparisons. It is also necessary in such comparisons to specify alternative plans and time periods very clearly.

When a new plan is put into practice, it is common to make capital disbursements for a period of two, three or more years, although benefits are not completely reflected in annual results until the fifth year or sometimes later. Thus, to make a complete comparison of two or three alternative plans, it would be necessary to prepare budgets for each plan during each transition year.

When a budgetary comparison is prepared for the transition years, capital disbursements should appear under operating expenses. The resulting net income will be expressed in terms of cash, and it will not be necessary to include depreciation figures for items newly acquired under operating expenses. Annual variations in surpluses or deficits can be determined by comparing one or more series of net income figures.

In many cases credit is necessary over the medium or long term to finance at least part of the new investments. There are two procedures to follow in this case:

– loans or principal payments can be included in annual plans, or

– a separate plan for loans and repayments can be prepared.

Comparing normal budgets

Even when only two plans are being compared, the procedures described above require a great deal of detailed planning work; if as many as four or five plans are involved, the quantity of work increases proportionately. One way to simplify the problem of making comparisons between two or more plans is to compare their performance for a normal year after the transition period has passed. This type of comparison appears in Form 3, where expenditures include the costs of replacing buildings and machinery as well as interest on new investments. These depreciation figures should be calculated using the procedures discussed in Part II of this text. The useful life of the equipment should be calculated not only on the basis of natural wear and tear, but also in view of the possibility that the article may become obsolete or useless. Interest charges on new investments should be calculated by averaging real cost and salvage value.

The net income estimates resulting from these procedures are equal to normal net income over a period of time long enough to cover the normal expenses needed for replacing fixed assets. However, these estimated figures will probably not be equal to net cash income for any one specific year.

This type of comparative budget can provide a very useful basis for selecting between various alternative plans, and it is useful for both the farmer and the analyst. Once a tentative selection has been made, the producer will have to develop more detailed plans for each year of the transition period.

Another useful calculation is the number of years needed to recover fixed capital investments. The purchase of a new stable is much more attractive if the investment can be recovered through additional profits over a period of five years rather than ten years or more.

A simplified comparison of the "normal" performance of alternative plans after a period of transition may leave much to be desired in the area of perennial crops such as fruit trees, forests or even coffee. In such cases some type of analysis is needed to show comparisons among a series of years or periods.

OTHER PLANNING PROCEDURES

There are several methods of analysis in addition to comparative budgets. The first is called simplified programming or systematic budgeting. It is based on a resource inventory and budgets for agricultural product lines in the enterprise. For this method, it is necessary to know the quantity of resources required per hectare of crops or per animal unit as well as net income for each activity. A series of systematic steps leads to the basic objective of determining the best plan for the agricultural enterprise. But its greatest value is that it can serve as a benchmark plan for analyzing the whole farming operation and thus exploring possible changes in the resource mix and in the various possible crops or operations. It can then be used for preparing the operating plan for the enterprise.

Linear programming is a systematic method for mathematically determining an ideal plan for the selection and combination of farm activities. The goal is to maximize income (or minimize costs) within the limitations of resources available to each farm.

SIMPLIFIED PROGRAMMING*

The literature on this method emphasizes a series of steps leading to the objective of developing an optimum farm plan. However, this method of farm planning should be limited to enterprises containing a maximum of ten operations or production lines. It becomes more difficult to use with more complex enterprises.

The basic objective is to maximize enterprise income by making the fullest and most advantageous use of each limiting resource. For example, if all the land is being used, the objective is to receive as much net income per hectare as possible.

Two hypothetical examples will be used to illustrate important steps in simplified programming. The first example will be presented in its simplest form to clarify the illustration of the method. The second example is a real case and shows how to overcome some of the difficulties that arise in the use of the method.

Table No. 6.1. Availability and limitations of fixed resources. Resource requirements by production line and net income of alternative lines.

Fixed resources and limitations	Quantity available	Resource requirements per hectare			
		Y_1	Y_2	Y_3	Y_4
1	2	3	4	5	6
X_1	40	1.25	1.0	1.0	1.0
X_2	5	1.00	0	0	0
X_3	10	0	1.0	0	0
X_4	30	1.25	1.0	1.0	0
Net income (income minus variable costs)		600	91	31	17

(*) This section follows the guidelines of Weathers[7].

The first step is to prepare Table 6.1, which provides the basis for other calculations. It is compiled by tabulating data from surveys of the given area. The available resources and the limitations on their use (X_1, X_2, X_3 and X_4) are given on the left-hand side of the Table. On the right are the resource requirements per hectare of the four crops (Y_1 Y_2, Y_3 and Y_4). At the bottom are net income figures for the four crops, as defined earlier.

Table 6.2 shows the maximum potential quantity of each crop or production line under the plan, as well as maximum net income per crop. Each crop is considered separately, as though the farmer's resources were all to go into the single production line. This Table is derived from Table 6.1 by dividing column 2 (quantity of the resource available) by the resources required for each crop (columns 3 to 6). The lowest number in the column for each crop represents the maximum level of resource which can be used for that crop under the plan. For example, crop Y_1 can use a maximum of five units of resource X_2, according to this plan. The other figures (32 and 34) are unimportant, as X_2 is the limiting resource for this group. The last line shows the maximum net income which can be obtained for each crop. It is calculated by multiplying the maximum resource figure by the net income given on the last line of Table 6.1. For Y_1, it would be 5 x 600 = 3 000 monetary units. Maximum net income for the remaining crops is calculated in the same way.

Table No. 6.2. Maximum potential number of units of each crop under the plan, and maximum net income per crop.

Fixed resources	Quantity available	Crops			
		Y_1	Y_2	Y_3	Y_4
1	2	3	4	5	6
X_1	40	32	40	40	$\boxed{40}$
X_2	5	$\boxed{5}$	–	–	–
X_3	10	–	$\boxed{10}$	–	–
X_4	30	24	30	$\boxed{30}$	–
Maximum net income		3 000	910	930	680

The next step is to calculate Table 6.3 for net income per unit of resource required. This is done by dividing net income (last line of Table 6.1) by the quantity of resources required for each crop (columns 3 to 6 of Table 6.1). In the case of Y_1, it would be $600 \div 1.25 = 480$, $600 \div 1 = 600$, $600 \div 1.25 = 480$ which are the net incomes for resources X_1, X_2, and X_4, respectively. All net income figures per unit of resource for crops Y_2, Y_3 and Y_4 are calculated in the same way.

Table No. 6.3. Net income per unit of resource required.

Fixed Resources	Crops			
	Y_1	Y_2	Y_3	Y_4
1	2	3	4	5
X_1	480	91	31	17
X_2	600	–	–	–
X_3	–	91	–	–
X_4	480	91	31	–

The last step is to prepare the farm plan on the basis of these three Tables. Table 6.4 gives a summary of the farm plan. The crops appear in Column 1, with available resources and limitations on the first line. The first step for developing this Table is to copy Column 2 from Table 6.1 (available resources) onto the first line of Table 6.4. Thus, $X_1 = 40$; $X_2 = 5$; $X_3 = 10$; and $X_4 = 30$. Then the crop which produced the greatest net income is determined with data from Table 6.2. For Y_1, this gives an income of 3 000 monetary units, see Column 7. Y_1 requires 5 units of resource X_2. This means that the maximum quantity of Y_1 under this plan is five. The quantity is then calculated for each of the other resources required by Y_1. This is done by multiplying the maximum quantity of product Y_1 (5) by Y_1's requirements for other resources, that is, $1.25 \times 5 = 6.25$ for X_1; $5 \times 1 = 5$ for X_2; $5 \times 0 =$ for X_3; and $1.25 \times 5 = 6.25$ for X_4. These figures are given on the second line, and resource requirements are then subtracted from fixed quantities of resources (line 1). This gives figures for crop Y_1 on excess resources and resources that will be depleted: 33.75 of X_1; 0 of X_2 (depleted); 10 of X_3 and 23.75 of X_4.

The next item to be considered in the farm plan is that crop, from among those remaining, which provides the greatest net income and does not require the use of the depleted resource. In this example, Y_2 provides a net income of 910, which is larger than that for Y_3

Table No. 6.4. Agricultural enterprise plan.

Crop and quantity of resources used per crop	Available resources	Fixed resources and limitations				Net Income
		X_1	X_2	X_3	X_4	
1	2	3	4	5	6	7
		40	5	10	30	
Y_1 = 5	Used	6.25	5	0	6.25	3 000.00
	Remaining	33.75	0	10	23.75	
Y_2 = 10	Used	10.0	0	10	10.00	910.00
	Remaining	23.75	0	0	13.75	
Y_3 = 13.75	Used	13.75	0	0	13.75	426.25
	Remaining	10.0	0	0	0	
Y_4 = 10	Used	10.0	0	0	0	170.00
	Remaining	0	0	0	0	
TOTAL						4 506.25

and Y_4. The maximum number of units of Y_2 to be introduced is 10, according to Table 6.2. Calculations are now made to obtain the quantity of resources used and resources still available (remaining). Thus, for X_1, the resource used is equal to 10 x 1= 10; for X_2 it is 10 x 0 = 0; for X_3 it is 10 x 1 = 10; for X_4 it is 10 x 1 = 10. These quantities are subtracted from the previously calculated figure for remaining resources, and a new value of resources available for crop Y_2 is obtained. It can be observed that crops Y_1 and Y_2 have depleted resources X_2 and X_3, leaving only two resources available for use.

The next crops to consider are Y_3 and Y_4, and Y_3 is found to provide the greatest net income using the undepleted resources and not requiring the use of those which have been depleted. This crop can use a maximum of 30 units of resource X_4. However, only 13.75 units of resource X_4 remain available after production of Y_1 and Y_2. Following the above procedure, resources used by Y_3 are calculated: 13.75 x 1 = 13.75 units of X_1 and 13.75 x 1 = 13.75 units of resource X_4.

The final crop, Y_4, gives an income of 170 and can use only the last 10 units of resource X_1. In this manner, the farm plan allows for all the resources to be used, yielding a total net income of 4 506.25 monetary units.

In a real-life case, the procedure is the same, as described below.

Selecting crops or production lines

The following factors should be taken into account when production lines are selected:

- resource availability;
- existence of product markets;
- desired objectives and a plan for implementing the program;
- the farmer's experience, interest and willingness to undertake the required task (type of crop, livestock, etc.);
- adaptability of crops and livestock to the farm conditions.

Preparing the budget by crop or activity

When the budget is prepared for each activity, the same data are needed: estimates of potential yield, product prices, and quantities and prices of input required.

As was mentioned in Chapter 3, the total cost of producing any product is the sum of fixed and variable costs. Overall costs, such as depreciation, maintenance, taxes, building insurance, and equipment used for various operations and not assignable to any individual activity, are not included in the budget by activity unless it is to be a new endeavor for which the necessary installations and equipment are not yet available. Nevertheless, the farmer may be interested in expanding the volume of business beyond the present capacity; in this case it would be advisable to prepare an additional budget to include variable production costs as well as fixed costs.

Preparing a table of available resources, limitations and resource requirements by enterprise and by unit

Particular care should be exercised in preparing this table to obtain accurate figures on the resource requirements for each crop or agricultural activity. It must also be understood that these requirements generally vary from farm to farm. Table 6.5 is given as an example. It includes figures for land, labor, capital investment, and other available resources. The table also specifies how much of each resource is needed to produce a unit of each of the outputs under consideration. The bottom of the table gives net income per hectare and per enterprise; also, limiting factors are indicated.

This table is based on previously selected products and on available information about the budgets of each enterprise. Figures are given on per-hectare requirements for each product line on the farm, and on resources available in each quarter. Thus, for example, for the April-June period, a hectare of potatoes (Column 5) requires one hectare of land, 2 975 m^3 of water, 26 worker-days of labor, and 10 171 monetary units of capital. Under available resources, April-June shows 5 hectares of land, 15 000 m^3 of water, 200 man-days of labor and 15 000 units of capital available. Likewise, resource requirements and availability for all the crops under consideration are given for the other months. The bottom of the table lists products which act as limiting factors, as natural soil conditions do not permit the use of more than 1.5 and 1.0 hectares respectively for these crops. The last line indicates net income per hectare and per product. It should be noted that, while special care is being given to the selection of activities, it is also important to classify resources accurately, in order to determine whether or not they really have a restricting effect. Thus, for example, in the illustrated case, water is one of the most restrictive resources and will subsequently limit the selection of certain lines. This will be demonstrated below.

Maximum quantity of each product or production line in the plan

Table 6.6 shows the maximum quantity for each crop, livestock project or agricultural line which could be produced if it were the only product included in the farm operation. In other words, each production line is considered separately for its use of the resources available to the farmer. This table is prepared by dividing the quantity of available resources (Column 2, Table 6.5) by the quantity of resources required by each product (Columns 3 – 10, Table 6.5). The lowest value in each column for each product represents the maximum quantity of the product which can be included in the farm plan. Thus, for example, in Column 3 (pigeon peas) the lowest value is 2.26 (see box), corresponding to water resources for April-June. It represents the maximum number of hectares of this crop which can be produced on the farm, because in this period water requirements are the major restriction on pigeon peas. Other data in this column are not important because the water resource for the period is the limiting factor for this crop.

Table No. 6.5. Fixed Resources: available quantities and effective limitations. Resource requirements by crop and net income for crop alternatives.

		Enterprise Requirements per Hectare							
Resources and Limitations	Quantity Available	Pigeon peas (March)*	Peanuts (October)*	Potatoes (May)*	Table tomatoes (December)*	Hybrid corn (May)*	Sweet corn (November)*	Cassava (October)*	Cotton (July)*
1	2	3	4	5	6	7	8	9	10
Land									
J-M	5 ha	1	1	0	1	0	1	1	1
A-J	5 ha	1	0	1	1	1	0	1	1
J-S	5 ha	1	0	1	0	1	0	0	1
O-D	5 ha	0	1	1	1	1	1	1	1
Water									
J-M	25 000 m^3	1 900	4 200	0	9 360	0	6 500	6 700	800
A-J	15 000 m^3	6 650	0	2 975	1 040	2 940	0	3 800	3 000
J-S	10 000 m^3	950	0	5 520	0	6 860	0	0	6 500
O-D	15 000 m^3	0	7 800	0	0	0	3 500	6 000	6 000
Labor									
J-M	250 man-days	11	37,5	0	34	0	26	7	23.5
A-J	200 man-days	20	0	26	108	25	0	31	9.5
J-S	200 man-days	13	0	25	0	10	0	0	20.0
O-D	200 man-days	0	27,5	16	38	15	25	21	17.0
Capital									
J-M	15 000	2 107	2 830	0	7 136	0	3 242	1 869	1 679
A-J	15 000	3 555	0	10 171	5 938	3 770	0	2 392	1 397
J-S	15 000	1 218	0	3 449	0	2 787	0	560	4 185
O-D	15 000	0	5 796	1 712	4 178	840	3 905	3 729	3 139
Potatoes (lim)	1.5 ha	0	0	1	0	0	0	0	0
Tomatoes (lim)	1.0 ha	0	0	0	1	0	0	0	0
NET INCOME $		1 979	3 672	5 758	12 239	3 343	3 113	7 112	895

(*) Planting month.
Data from production costs study for various crops in the Chincha zone, OAS Program, Israel, 1966.

Table No. 6.6. Maximum number of units of each potential crop in the plan. Maximum net income per crop. Data based on Table 6.5.

		ACTIVITIES							
Resources	Quantity Available	Pigeon Peas	Peanuts	Potatoes	Table Tomatoes	Hybrid corn	Sweet corn	Cassava	Cotton
1	2	3	4	5	6	7	8	9	10
Land									
J-M	5 ha	5	5	–	5	–	5	5	5
A-J	5 ha	5	–	5	5	5	–	5	5
J-S	5 ha	5	–	5	–	5	–	–	5
O-D	5 ha	–	5	5	5	5	5	5	5
Water									
J-M	25 000 m^3	13.16	5.95	–	2.67	–	3.85	3.73	31.25
A-J	15 000 m^3	$\boxed{2.26}$	–	5.04	14.42	5.10	–	3.95	5.00
J-S	10 000 m^3	10.53	–	1.81	–	$\boxed{1.46}$	–	–	$\boxed{1.54}$
O-D	15 000 m^3	–	$\boxed{1.92}$	–	–	–	4.28	$\boxed{2.50}$	2.50
Labor									
J-M	250 man-days	22.73	6.67	–	7.35	–	9.61	35.71	10.64
A-J	200 man-days	10.0	–	7.69	1.85	8.00	–	6.45	21.05
J-S	200 man-days	15.38	–	8.00	–	20.00	–	–	10.00
O-D	200 man-days	–	7.27	12.50	5.26	13.33	8.00	9.52	11.76
Capital									
J-M	$ 15 000	7.12	5.30	–	2.10	–	4.63	8.02	8.93
A-J	15 000	4.22	–	$\boxed{1.47}$	2.53	3.98	–	6.27	10.74
J-S	15 000	12.32	–	4.35	–	5.38	–	26.78	3.58
O-D	15 000	–	2.59	8.76	3.59	17.86	$\boxed{3.84}$	4.02	4.78
Potatoes (lim)	1.5 ha	–	–	1.50	–	–	–	–	–
Tomatoes (lim)	1.0 ha	–	–	–	$\boxed{1.00}$	–	–	–	–
NET INCOME $		4 472	7 050	8 464	12 239	4 880	11 954	17 780	1 378

The net income obtained for each line is found by multiplying maximum land surface area per product line (minimum value figures in the table) by the net income which appears in Table 6.5. These figures are given in the last line of Table 6.6. For pigeon peas, we find: 2.26 x 1 979 = 4 472.

Calculating net income per unit of resources

The net income per unit of resources is calculated by dividing net income per unit of product (last line of Table 6.5) by the amount of the resource required for this product line. Thus, for example, net income per hectare of cassava in the January-March period is 7 112 monetary units, found by dividing 7 112 by 1 hectare. The net income for the other products can be calculated in the same way. This table is useful because it shows how to plan the most efficient use of the scarcest resources. For example, if capital is the scarcest resource in the July-September period, we would search for the most profitable activity in terms of capital use for this period by studying the proper line on the table. In this example, cassava is the highest-paying operation, earning 12.70 monetary units (see Table 6.7).

Preparing the farm plan

The purpose of planning is to select the combination of product lines which will produce maximum income with given available resources. To this end, every resource used in the production of a given crop or livestock endeavor should go into that production line which yields the highest income per unit of resource consumed. This principle should be maintained throughout the entire farm planning process.

The first step in planning the farm operation using Tables 6.5 and 6.7 is to extract the resource figures from Table 6.5 and record them on the first line of Table 6.8 as available resources. An example would be: land in January-March – 5 hectares; water for April-June – 15 000 m^3. Then a product line is chosen from Table 6.6 for consideration in the farm plan, selected on the basis of net income yield. In the example, it is 2.5 hectares of cassava, yielding a high net income of 17 780 monetary units. If cassava is included in the plan, water resources will be depleted in the October-December period (Table 6.8).

Table 6.7 shows that cassava gives the maximum return on the use of the depleted resource (water, for a cost of 1.19 monetary units), and therefore, this is the correct decision. With the use of Table 6.5, the quantity of each resource needed for 2.5 hectares of cassava can be determined. This is done by multiplying 2.5 by the quantity of resource required, as given in Table 6.5. The result appears on line 2 (resources used–cassava).

The next step is to determine which other products should be included in the plan. Table 6.6 can be used to select the activity yielding the highest net income after cassava, with no requirements for the depleted resource. In this case it is tomatoes. How much tomatoes can be included in the plan? To answer this question, the resources remaining after the cultivation of cassava (Table 6.8) are divided by the tomato requirements (Table 6.5), or 8 250/9 360, which gives 0.881 hectares. This will deplete water resources for January-March. To determine whether or not water has been correctly distributed, Table 6.7 can be used to show that tomatoes give the best return on capital (1.31) for the use of water in this period, and therefore they are formally included in the plan. Table 6.5 can be used to determine the quantity of each resource used for 0.881 hectares of tomatoes (see line 4 of Table 6.8).

The next product to be considered according to Table 6.6 is corn, a crop which would require water during January-March. The water, however, was depleted by the tomatoes. Table 6.7 shows that tomatoes pay better than corn, so corn is eliminated from the plan.

Returning to Table 6.6, we find that potatoes would be the next crop. However, potatoes would be unsuitable because of limited capital for April-June and the large capital requirements in this period for potatoes. Peanuts would be next. This crop requires water in October-December (Table 6.5). However, water was depleted by cassava, which pays better than peanuts (Table 6.7), so peanuts are not included in the plan.

The next crop (Table 6.6) is hybrid corn, which needs none of the resources already depleted by the previous crops, and can therefore be included in the plan. The best quantity of hybrid corn can be determined by dividing the amount of resources remaining after the production of cassava and tomatoes (Table 6.8) by the requirements for the new crop (Table 6.5): 3 789 (capital for April-June) divided by the hybrid corn requirements. Included in the plan, this corn will deplete capital for April-June (Table 6.8), but will be better remunerated than any of the other products listed on Table 6.7.

Table 6.8 shows that some resources have not been depleted and are still available for the cultivation of other products not yet included in the plan.

Table 6.6 presents data on the crops still available for consideration: pigeon peas and cotton. In Table 6.5 it can be seen that pigeon peas need water in January-March, but the water has been depleted by tomatoes. Which of these crops provides a better return on water use? Table 6.7 shows that tomatoes pay more than pigeon peas, so pigeon peas are not included in the plan. Cotton is then omitted for the same reasons.

In conclusion, under these given conditions, the combination of products yielding maximum net income is:

Cassava:	2.500 hectares
Tomatoes:	0.881 hectares
Hybrid corn:	1.005 hectares

for a total net income of 31 923 monetary units.

Table No. 6.7. Net income per unit of required resources (data based on Table 6.5)

	PRODUCTS							
Re-sources	Pigeon Peas	Pea-nuts	Pota-toes	Table Toma-toes	Hybrid corn	Sweet corn	Cassava	Cotton
1	2	3	4	5	6	7	8	9
Land	$	$	$	$	$	$	$	$
J-M	1 979.00	3 672.00	–	12 239.00	–	3 113.00	7 112.00	895.00
A-J	1 979.00	–	5 758.00	12 239.00	3 343.00	–	7 112.00	895.00
J-S	1 979.00	–	5 758.00	–	3 343.00	–	–	895.00
O-D	–	3 672.00	5 758.00	12 239.00	3 343.00	3 113.00	7 112.00	895.00
Water								
J-M	1.04	0.87	–	1.31	–	0.48	1.06	1.12
A-J	0.30	–	1.94	11.77	1.14	–	1.87	0.30
J-S	2.08	–	1.04	–	0.49	–	–	0.14
O-D	–	0.47	–	–	–	0.89	1.19	0.15
Labor								
J-M	179.91	97.92	–	359.97	–	119.73	1 016.00	38.08
A-J	98.95	–	221.46	113.32	133.72	–	229.42	94.21
J-S	152.23	–	230.32	–	334.30	–	–	44.75
O-D	–	133.53	359.88	322.08	222.87	124.52	338.67	52.65
Capital								
J-M	0.94	1.30	–	1.72	–	0.96	3.81	0.53
A-J	0.56	–	0.57	2.06	0.89	–	2.97	0.64
J-S	1.62	–	1.67	–	1.20	–	12.70	0.21
O-D	–	0.63	3.36	2.93	3.98	0.80	1.91	0.29
Potatoes (lim)	–	–	5 758.00		–	–	–	–
Tomatoes (lim)	–	–	–	12 239	–	–	–	–

It should be emphasized that even though it is important to determine a combination of crops which will maximize net income, the plan has other important uses, such as analyzing the total agricultural operation to determine necessary changes in the combination of resources and in work plans.

The plan we have just traced shows that labor was not fully occupied, especially in January-March, with 19% occupation, and July-December, with 5%. This means that labor is not well balanced

Table No. 6.8. Farm Plan for the Agricultural Enterprise.

	RESOURCES AND LIMITATIONS																		
	LAND				WATER				LABOR				CAPITAL						
ACTIVITIES	J-M	A-J	J-S	O-D	J-M	A-J	J-S	O-D	J-M	A-J	J-S	O-D	J-M	A-J	J-S	O-D	Potatoes (Limit)	Tomatoes (Limit)	Net Income ($)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1. Resources Available	5	5	5	5	25 000	15 000	10 000	15 000	250	200	200	200	15 000	15 000	15 000	15 000	1.5	1.0	0
2. Resources used (Cassava)	2.5	2.5	0	2.5	16 750	9 500		15 000	17.5	77.5		52.5	4 672	5 980	1 400	9 217	–	–	17 780
3. Unused Resources	2.5	2.5	5	2.5	8 250	5 500	10 000	0	232.5	122.5	200	147.5	10 328	9 020	13 600	5 683	1.5	1.0	
4. Tomatoes	0.881	0.881		0.881	8 246	916			30	95	–	33.5	6 287	5 231		3 680	–	0.881	10 783
5. Unused Resources	1.619	1.619	5	1.619	±0	4 584	10 000	0	202.5	27.5	200	114	4 041	3 789	13 600	2 003	1.5	0.119	
6. Hybrid corn	0	1.005	1.005	1.005	0	2 954	6 894	0	0	25.0	10	15	0	3 789	2 800	844	0	0	3 360
7. Unused Resources	1.619	0.614	3.995	0.614	0	1 630	3 106	0	202.5	2.5	190	99	4 041	0	10 800	1 159	1.5	0.119	31 923

with respect to other resources. During July-September, 3 995 hectares of land, 3 106 m^3 of water, 190 worker-days of labor and 10 800 units of capital were left idle. Would it be possible to introduce a crop with a short growing cycle to use the idle resources? What are the possibilities for introducing a strain that will require the employment of the excess labor? What would happen if we altered the planting seasons for some of the crops? These and other questions can be solved rationally by using the plan presented above as a basis and introducing simplified programming.

In our example, we sought an optimum combination of products for using a fixed set of resources. If changes occur in the quantity of some of the limiting resources, the combination of products must change as well. This has implications for the net income of the farm as a unit.

If available irrigation water in this example were increased, the combination of enterprises would be different, although the procedure for replanning the farm would not change. It would only be necessary to figure in the amount of the resources and measure its implications for the combination of products and for the plan as a whole.

LINEAR PROGRAMMING

According to Yang[8] linear programming is a systematic method for mathematically determining the desirable means of obtaining optimum results. It is a planning method that maximizes an objective function. At the same time, it requires the recognition of certain restrictions or limitations on the potential solution. Its use in farm planning and analysis is well known. Many studies have been made on minimizing the cost of cattle feed mixes, on selecting and combining optimum livestock, crop and other farm products, and on selecting crop rotation patterns.

This method of analysis requires essentially the same information as the budgeting method. Therefore, estimates of prices, yields and input costs and quantities are needed. In contrast to the budgeting method, linear programming is based on four assumptions (Yang[8]):

– that the physical requirements are fixed for each production factor for each product. Thus, for example, if a hectare of potatoes requires 100 man-days of labor, 10 hectares will need 1 000 man-days. In other words, a constant factor-product ratio is assumed;

– that the farm's resources (land, labor and machinery) as well as the lines of production are divisible and accumulative in order to achieve maximum net income. For example, it would be possible to have 2.7 tractors or to plant 0.015 hectares of land and produce 9 837.6 liters of milk in order to maximize income;

– that each agricultural production line is independent of the others and that the selection of one does not imply the selection of another. For example, corn can be grown whether or not hogs must be fattened; cows can be raised whether or not pastures are available;

– that the number of production lines which can be adopted is finite and, therefore, the selection and combination of operations must fit in with this finite availability.

Many economists criticize any method of analysis involving such restrictions; others feel that field work, experimental evidence and careful presentation of the problem are the keys to any method of analyzing the agricultural enterprise; some have doubts about the linear assumptions; others find that linear relationships closely approximate the majority of relationships found on the farm and that it is of key importance to define the linear segments appropriately.

Another type of limitation which makes itself felt on the individual farm as well as for groups of farms is the non-homogeneous nature of resources. This problem can be partially solved by determining the farms, or areas within a single farm, that have more homogeneous resources; but the price of this fine tuning is an added load for the tasks of computation and analysis.

At the same time, this technique isolates itself from the total problem, either in its administrative aspects or in other elements of the enterprise, because markets, price of products and inputs, and the products themselves are treated as subjective truths in the minds of those who do the analysis. A matrix is constructed by which some value is maximized or some cost is minimized. Such abstraction must be remembered when this method of analysis is used. However, it should also be recognized that all types of analysis use some abstraction.

Types of problems for which linear programming is used

According to McCorkle[2] this analytical technique can be used to solve four types of problems:

Minimizing production costs for a given product. Preliminary efforts have been made to apply linear programming to the problem of minimizing the cost of producing one or more crops which have specific characteristics. These experiments have been conducted in the field of agricultural economics.

Distributing resources among alternative production lines. When a high number of alternatives or practices is available, linear programming can simplify data processing to reach a solution, generally cast as an optimum combination of inputs and methods to minimize costs. The solution will be optimum only if the definition of the problem and the information present the lowest-cost alternatives. Another type of problem in this category is how to select the optimum combination of products so as to maximize the profits of the farm viewed as a single unit.

Determining the optimum level of a given input. This type of problem can be solved with linear programming; however it is not advantageous to do so, as marginal analysis provides a much more direct approach.

Other problems. In addition to the problems of the individual farm, others include:

- measuring the economic impact of various policies on a segment of the rural population;
- measuring the direct impact of new technology on a farming segment;
- promoting the integral development of a watershed basin;
- making optimum use of resources over time.

All these tasks use the same basic technique of linear programming. That is, for any type of problem, basic decisions must be made on: selecting potentially profitable product lines; determining the limiting factors; specifying the requirements of each production line; and determining input costs, production costs and production values.

BENEFITS OF AGRICULTURAL MANAGEMENT ANALYSIS

Under these conditions an analysis of agricultural management can help to:

- stimulate the farmer to think about possibilities for change;
- suggest promising alternatives; and

– provide the means for adopting these alternatives through the use of comparative budgets, simplified programming or linear programming.

These three benefits follow a logical sequence, but the agricultural management specialists do not always need to participate in all three phases. In some cases their greatest contribution may be to encourage farmers to think about the opportunities for obtaining better results. However, they must often help the farmer to draw up and select well-defined alternative programs. This is most necessary when simplified programming or linear programming are used.

INCENTIVES TO MAKE THE PRODUCER THINK ABOUT CHANGE

Data from surveys or farm records can provide the farmer with incentives for thinking about the magnitude and direction of opportunities for improving operations. Data can be presented in one of three different ways, according to how they will be interpreted or used.

One is designed to show the farmers how the performance of their operations compares with that of other farms. The farmer may be open to the possibility of making administrative improvements when presented with figures on income levels in other, similar enterprises. Likewise, knowledge of physical yields obtained per hectare, per animal, per hour of labor or per ton of feed may provide an incentive. Sometimes it can also be help to present current rates of production in economic terms, such as net income for each 1 000 monetary units of invested capital or for each 1 000 monetary units of paid labor. These ratios can give an idea of the high, low or intermediate performance of groups of farms.

Agricultural management specialists are well aware of the wide production swings which can occur in almost any group of farms during the course of a single year. For example, in a series of case studies on the wheat-producing zone of Nariño, Colombia, six producers reported yields which fluctuated between 400 and 900 kilograms per hectare, while two others reportedly obtained 2 600 and 1 400 kilograms respectively. At the same time, on nine farms selected for case studies in the Department of Cundinamarca, wheat yields varied from 700 to 3 600 kilograms, with an average of 1 900 kilograms. Probably none of these producers knew whether average wheat yields in Colombia were above or below 1 000 kilograms per hectare, since even official estimates were inconsistent.

In these same groups of producers, five reported yields of 600 kilograms or less of barley per hectare, while others obtained 1 200 and up to 2 100 kilograms. (In general, barley yields in Colombia have recently increased to a level of more than 2 000 kilograms per hectare.)

Similar variations occur in the per-head production of milk on farms studies in various regions of Colombia. Five producers in the Cauca Valley reported yields of 3 to 5 liters of milk per cow per day, four producers from Cereté reported lower averages, while three from Cundinamarca obtained 7 to 8 liters per day. All these rates of production are very low by comparison with figures for the most prosperous dairy farms of Colombia, the United States or Great Britain, where per-head milk production frequently exceeds 15 or 20 liters of milk daily.

The extreme variations in yields mentioned above do not necessarily prove that any particular producer could have obtained a higher net income by selecting different production methods or lines. Yields are affected by soil potential, weather, and other environmental conditions whose effects can vary significantly from one farm to another and from year to year. As a result of these variations, a farm which produces high yields one year may have very low yields the following year. Nevertheless, many producers are unaware of the year-to-year production differences on neighboring farms. An understanding of these variations and their effect on the output of specific farmers can provide a great incentive for them to seek more economic levels of production by means of a more appropriate combination of production lines or methods.

Another method for presenting data obtained from farm records or surveys is to associate high incomes with the high-level application of some of the relationships mentioned above. Farms could be classified according to milk production per cow, sales per unit of investment, or total volume of business per farm, and the corresponding net income figures would be clearly stated. In other cases the opposite procedure could be followed, with low or high income farms described in terms of factors which are considered highly important. Some researchers have tried to apply more refined methods of correlation analysis instead of limiting themselves to informal methods of classification and subclassification.

A final method involves calculating the comparative profits of various product lines on a particular farm or among various similar farms. At one time agricultural economists believed that complete cost accounting for all products could be extremely helpful in guiding management programs toward the most profitable areas. However, the greatest difficulties arise when overall or group costs are assigned to the various product lines; management theory establishes very clearly that overall or group costs should not be considered when the selection is made or the size of enterprises is determined. In addition, most of these techniques have the same difficulties in making valid inter-farm comparisons.

All the methods described can help give the campesinos an incentive to think about the profit potential of making managerial changes and about the directions these changes should take. Each of these methods can easily be misinterpreted, generally because methods which have proven highly successful on some farms can be inadequate on others, where available resources differ considerably in quantity or quality. In many cases, the "success factors" do not take into account the interrelationships inside the agricultural enterprise; thus, on a diversified farm it may be advantageous to accept relatively low levels of production on a complementary or supplementary production line in order to concentrate greater attention on the major product. Finally, all the incentives discussed here are based on historical data, and therefore constitute a look backward rather than a look into the future.

PROJECTING THE MOST PROMISING ALTERNATIVES

Perhaps the most difficult aspect of an agricultural management analysis is to move from a state of mild dissatisfaction with existing performance to the stage in which certain specific managerial alternatives are defined and implemented with the use of comparative budgets or other methods. Generally, such management alternatives include one or more of the following changes:

– adding or eliminating products;
– increasing or decreasing operating size;
– replacing an input of a given type or quality with another;
– readjusting the proportion of inputs, such as feed or fertilizers.

Previous, systematic tests of all possible combinations of individual changes would be an interminable task. Therefore, only the most promising alternatives should be selected for careful study. At times this is difficult because of complicated interrelationships among various parts of the farm.

When a rancher replaces forage with concentrates, complementary changes should be considered in the total program of crops and fertilization, in the proportions of feed needed by various classes of cattle, in the machinery to be used and in the quantity of labor required. One change leads to another, and only certain combinations of various changes can constitute a practical alternative. Some changes made as a whole can have a beneficial effect on the enterprise, although any one of them made separately may be detrimental.

The selection of the most promising alternatives is more an art than a science and will be accomplished more effectively as experience is accumulated in analyzing agricultural enterprises.

There are serious doubts about the usefulness of a systematic procedure to complete this task. Some texts on agricultural management recommend that plans for a crop program be followed with plans for livestock, so forage from crops can be put to use. However, it is often equally appropriate to adopt the opposite approach to these methods. At times it is necessary to change the quantity of labor and equipment, accomodating them to crop and livestock products. At other times it is more realistic to begin with a given quantity of labor.

Buildings could be either the first or the last factor to be considered. Market and price behavior should not be overlooked, although it may be the last factor to come under analysis before the final decision is made. No isolated factor will always be of decisive importance. Sometimes attention should be concentrated on reducing expenses, and other times, on increasing revenues. However, it can almost be assured that any substantial change implies increases or decreases in revenues or expenditures. The fact is that one should begin with a very complete knowledge of the agricultural enterprise as a whole, and of the interrelationships among its parts, and be prepared to adopt whichever alternative proves to be the most appropriate.

METHODS FOR TESTING ALTERNATIVES

The two methods of analysis discussed above are useful for solving some of the problems of the agricultural enterprise. To these should be added marginal analysis, as presented in Chapter 3. Table 6.9 presents a summary of the characteristics, objectives, uses and limitations of the three methods of analysis. It should be noted that the simplest and easiest of the three methods is budgeting. However, any system of analysis should give special attention to defining the problem, establishing the conceptual framework of analysis, and selecting the appropriate information.

Table No. 6.9. Selected characteristics of three methods of analysis.

Characteristics and uses	Linear Programming	Marginal Analysis	Comparative Budgeting
Types of information required	• Resource availability* • Estimated future prices • Input costs • Estimated possible yields	• Resource availability* • Estimated costs and future prices for each alternative • Estimated possible yields	• Resource availability* • Estimated costs and future prices for each alternative • Estimated possible yields
Basic assumptions and requirements	• The objective or basic goal is to maximize income or minimize costs • Linear production functions • Divisibility and homogeneity of resources and production lines • Independent production lines • Each production line selected should be developed at its highest income level • Finite number of product lines • Requires vector algebra and use of computers	• The objective or basic goal is to maximize income or minimize costs • Divisibility of resources and product lines • Requires knowledge of management theory such as input-output and input-input relationships • Cost and income functions	• The objective or basic goal is to maximize income or minimize costs • Requires arithmetic • Analysis is based on variable costs

Table 6.9. (Cont.) Selected characteristics of three methods of analysis.

Characteristics and uses	Linear Programming	Marginal Analysis	Comparative Budgeting
Major Applications	• Minimize production costs for a given product • Distribute resources among various alternatives • Optimize level of input use • Optimize use of resources over time • Draw up overall plan of the firm	• Optimize level of input use • Select and optimize a combination of product lines, taking into consideration the limitations for more than two products • Minimize production costs for a given product	• Select and combine product lines inside the enterprise • Provide a planning and management tool for the individual agricultural enterprise • Draw up alternative plans for the enterprise

(*) The quantity and quality of resources available for production conditions and defines the selection and size of activities or product lines.

SUMMARY

Programs for agrarian reform, supervised credit, settlement, and implementation of development plans introduce the need to analyze and plan agricultural enterprises, either for reorganization or for the creation of new operations.

Procedures that have been successfully used for enterprise planning include budgeting, simplified programming and linear programming.

Marginal analysis is an analytical technique useful for decision-making on the optimal level of input use, selecting and combining product lines and determining the minimum costs of obtaining a given output.

Comparative budgets are useful for evaluating the alternative actions, or the plans for the agricultural enterprise.

Simplified programming strives to maximize the net income of the enterprise. The goal is to use each limited resource for the production line which yields the greatest benefit.

Linear programming is a systematic method for mathematically determining how to obtain optimum results. It is based on various hypotheses such as the divisibility and homogeneity of resources, linear production functions, etc., which impose certain limitations on its use. This method is very helpful for finding the minimum cost of production of a given product, for distributing resources among various alternatives, for determining the optimum level of input use (although marginal analysis is preferable for this purpose) and for making optimum use of resources over time.

The analysis and planning processes require information on the following factors: resource availability, estimated future prices, input costs and estimated possible yields.

QUESTIONS

1. What is partial budgeting and how does it differ from total budgeting for the enterprise?

2. What are comparative budgets and how are they used?

3. Briefly describe the basic assumptions and information requirements for a) budgeting and b) marginal analysis.

4. What are the hypotheses upon which linear programming is based?

5. What planning methods do you consider most appropriate for the region where you work? Explain why.

6. Prepare a table comparing the advantages and disadvantages of the analytical methods described in this chapter.

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CHAPTER 7

FARM MANAGEMENT ANALYSIS IN AN INTEGRAL ECONOMIC DEVELOPMENT PROGRAM

From the previous chapter it can be concluded that the objectives of management analysis focus on two different levels: the producer or individual enterprise, and the agricultural production process consisting of all the enterprises in a country. On the first level, the basic objective is to determine how to help the farmer make wise decisions for improving the efficiency of the use of resources in a way that is compatible with society's well-being. On the second level the objective of analysis is to provide data to help the decision-making process on regional and national levels. That is, it must improve the planning of agricultural policy and the orientation of the institutions which control production.

This chapter will look at some major contributions of farm management analysis, present ideas on the measures needed to make these contributions feasible, and provide a sequence for analysis.

THE ROLE OF FARM MANAGEMENT IN AN ECONOMIC DEVELOPMENT PLAN

In order to understand the role that research and analysis of agricultural businesses should play in the context of economic development, it is helpful to understand the meaning of development itself. FAO and IICA define it as follows:

"Development does not mean simple economic growth whose limited purpose is to bring about a quantitative increase in productive capacity. The United Nations and the Inter-American System have repeatedly acknowledged development as a broad ideological concept which implies a reorientation of political and social power, a redistribution of income and the broad-scale participation of all sectors of the population in political and social institutions. To achieve this, development in Latin America should be approached as a process of structural change; this implies production changes as well as institutional changes and requires the creative participation of the total population."

This definition is meaningless if governments do not make the political decisions required to put development into practice.

The majority of Latin American countries, as well as their states and political subdivisions, are actively engaged in preparing plans and programs for economic development. The goals of economic development are frequently expressed in terms of changing the "gross national product' or similar statistical measurements. However, these variables cannot be manipulated directly through action programs.

Incentives and controls on savings, investment, international trade, the money supply and other variables of the total economy are indirect ways of controlling the pace of economic development. If these measures are to be effective in guiding the economy, they must trigger actions with specific results, adopted by decision-makers in operating units throughout the economy, in both the public and the private sectors. If the indirect measures do not influence these people, they cannot produce the desired impact on the economy.

For example, a country which imposes strict import controls and regulates major industrial investments could authorize the construction of a fertilizer factory as a means of expanding agricultural production. However, a decision of this nature does not ensure the construction of the fertilizer factory, by either the public or the private sector. Nor does it ensure that the agricultural producers of the country will make proper use of the additional fertilizers produced.

Economic development programs should be designed for the purpose of obtaining certain desired responses from individual operating units. Frequently, this requires an integrated combination of activities at local, regional and national levels. Facts must be available on the possible behavior of the operating units, both separately and as a whole. This holds true for production units and consumption units, agricultural or non-agricultural, in the public and private sectors. This is why integrated programs of economic development must include farm management analysis. Such programs can either concentrate on agriculture or expand to cover the total economy.

INCENTIVES FOR DEVELOPMENT PLANS

It was noted above that the campesinos must make decisions on how to combine available resources, and that a country's total production is made up of the sum of the production of all the individual units of the country or region. This implies that the campesinos play a very important role in the execution or introduction of agricultural development plans. However, if this function is to be effective, incentives and measures must exist to guarantee the fulfillment of the plans.

These incentives and measures could be grouped as shown below. The categories were taken from Schickele[3] and Mosher[2], but have been slightly expanded.

- Local availability (retail distribution) of critical inputs such as fertilizers, seeds, pesticides and machinery.

- Credit facilities for production, including training in the efficient use of credit.

- Favorable cost-price relationships, or a situation which minimizes uncertainty and reduces price risk, especially in periods of production rises.

- Definition of land tenure conditions. The definition of the type of land tenure, either as traditional small and medium ownership (usually family) or as associative enterprises, provides the campesino a certain margin of security by establishing a general framework within which to make decisions. Among other things, it means that land rental, taxes and debts will not surpass the limits beyond which the farmer can justify the effort, cost and other risks involved.

- Protection against the risk of adopting new technologies unknown to the farmer, often untested in the zone, and not well understood. This presupposes the need for regional tests and some type of crop insurance.

- Marketing facilities for agricultural products, including a network of roads connecting farms with local markets and facilities for storage, grading and product distribution.

- Extension or technical assistance services for the producer.

- Efforts to encourage and create means by which the campesinos can participate effectively in political power through cooperatives or other organizations created for such purposes.

- Replacing purely descriptive and physical-biological research with an approach oriented toward problem solving with socio-economic components.

- Finding improvements adaptable to the surrounding conditions, providing the farmers with incentives, and training them to adopt modern production processes.

- Establishing methods and procedures for farm planning, taking into account environmental conditions, estimates of input-output relationships and the plans and budgets for typical farms growing the major crops on a regional and national level.

- Subdividing national goals into regional and local components according to the production potential of various agricultural enterprises.

- Narrowing the gap between national production requirements and production potential on the level of agricultural enterprises by harmonizing and adjusting national goals according to local capabilities.

- Vigorously promoting tests and demonstrations of development plans and budgets on selected farms in pilot areas. This should be complemented with carefully prepared lectures tracing similarities and discussing experiments with input-output ratios, socio-economic policy and results obtained under similar conditions in other regions.

CONTRIBUTIONS OF FARM MANAGEMENT

Farm management analysis can serve economic development programs in four specific ways:

- Providing a basis upon which to plan public programs in a given framework of political and social institutions.

- Providing a guide for planning modifications in public institutions, such as structuring new Agrarian Reform legislation.

- Providing a basis for instructional programs in universities and other educational institutions.

- Providing a basis for extension programs directed toward individual producers. These programs can be undertaken by universities or other public entities.

Sometimes people who work in farm management overlook the first two objectives mentioned above. As a result, public opinion frequently views this work as a service to individual producers. This does not mean that the final two objectives are disdained or ignored; we would simply like to emphasize that farm management has much to contribute on both the overall level and the microeconomic level.

A SEQUENCE FOR ANALYSIS

It is not possible to present a precise outline of proper procedures for all research of farm management problems. However, analysts of these problems should cover a series of stages which include all or most of the activities listed below. These stages are presented in a logical sequence, but if they are to meet the needs of specific situations, the order will have to be changed.

Identifying situations related to the type of farming used

In most countries, farming practices vary considerably, but seldom does a single large area contain a random distribution of all types of plots. Characteristic types of agriculture tend to be developed in specific geographical areas due to influences of:

– physical variations in soils and topography;

– historical variations in tenure patterns and other social institutions;

– economic variations in the availability of markets and important inputs.

Some areas are developed with a clear predominance of one single type of specialized plot or farm. This is the case of the sugar cane areas of Colombia or the potato production centers on the Island of Chiloe in Chile. Other areas develop a diversity of products obtained through various types of specializations, as occurs along must of the Peruvian coast or on the Colombian Atlantic coast.

In other areas, the predominant type is the diversified farming and livestock enterprise, as found in the Savanna region of Bogota.

In addition to the degree of specialization, other variables should come under consideration for designing maps to delimit typical areas of agriculture. Two such variables are tenure and intensity of input use.

Generally, a high degree of precision is not required for delineating areas by type of agriculture; any simple chart of easily identifiable areas would considerably simplify farm management analysis.

Classifying farms by type within a selected area

In order to obtain a clearer idea of the major existing trends, it is important to develop some kind of system for classifying a sample of the farms in the area, according to the types of agriculture described above.

Within a reasonably homogeneous area, a brief (one-page) survey of 150 to 250 farm units can provide this type of information and constitute a basis for selecting more detailed case studies, as was mentioned earlier. In Colombia a survey of this type was done for about 800 farm units in five separate areas (see Form 6). In each area a team of two students in their fourth year of studies at the Medellin School of Agronomy visited about 160 farms over a period of less than 15 working days. The interviews took about 15 minutes and the majority of the time was spent travelling from farm to farm.

This survey made it possible to classify farms in each area according to the combination of product lines, size and tenure (Table 7.1). Based on these characteristics, it was possible to identify between 5 and 10 common agricultural patterns in the area. The survey also provided information about the composition and characteristics of the operators' families, sources of technical information actually known to the farms and various cropping practices typical of the area.

Selecting units for in-depth case studies

Once a list of farms representing each of the different agricultural patterns in the area has been drawn up, the next step will be to select certain units to be analyzed individually. Each major category of farming should be represented by one to three farms; they can be chosen randomly or selectively, following a careful examination of the various cases included in the representative groups.

However, "representative" farms selected for case studies should only be considered as parts of the total sample. It is also worthwhile to develop case studies of farmers who have been "pioneers" in adopting new methods or operations in the area or who handle businesses which are substantially different from the typical patterns of the area.

Analyzing enterprises selected for case studies

As the objec ves of these two types of case studies are substantially different, the form of analysis should also vary. For "representative" cases the analysis is primarily a look into the future, including

Table No. 7.1. Classification of 163 agricultural enterprises in Fredonia Municipality, Antioquia (Colombia), by type, size and tenure*.

Type of farm and tenure	Farm Size (in blocks)				Total
	1.0-4.9	5.0-9.9	10.0-49.9	50 or more	
Coffee (C)					
– owner	49	27	32	5	113
– sharecropper	7	1	2	–	10
Mixed (M)					
– owner	2	3	–	–	5
– sharecropper	2	2	–	–	4
Diversified (D)					
– owner	7	3	9	9	28
– sharecropper	2	–	–	–	2
– renter	1	–	–	–	1
Total	70	36	43	14	163

(*) Interviews were also held on 20 small farms classified as "Subsistence".

the use of comparative budgets, to evaluate the various alternatives for the future, on the basis of the methods of analysis illustrated in Chapter 6.

However, the study of "pioneer" farms looks at the past and seeks to evaluate current experiences with product lines or unusual methods that could be valuable for other farms.

This type of evaluation can be applied, for example, to new forms of land tenure or labor relations, as well as new crops or production practices.

Form No. 6 Example of preliminary survey.

NATIONAL SCHOOL OF AGRONOMY, MEDELLIN
PRELIMINARY SURVEY FOR
A STUDY OF FARMING CHANGES

Strictly Confidential

Department:	Antioquia	A: C (Coffee)
Municipality:	Fredonia	B: O (Owner)
Route:	Zabaletas	C: 3 (10.49 blocks)
Enumerator:	Chacón	
Date:	December 2, 1972	

Farm "R" 3 Km from Fredonia on the road to Amaga

1. ¿Who is in charge of the farm? (Name)
2. ¿Does this person run the farm independently? Yes

(address)

3. Who is the producer? Same — Class I ____ Class II X

   (address)

4. What is the primary occupation of the producer? Farmer
5. For renters or sharecroppers, indicate owner ____
6. How many months did the producer reside on this farm during 1972? ____
7. Data on the farmer, all persons living in the principal dwelling of the farm, and any children of the producer's who lived elsewhere in 1972:

Relation to farmer	Sex		Age (App.)	Civil status				Student	Education*			Worked on farm			Worked off farm	
	M	F		S	M	W	O		Y	R	W	months	days per month	total days	total days	in agriculture
Producer	X		50		X			No	No	Yes	Yes	3			no	(sick part
Spouse		X	35					No	3	Yes	Yes	3			no	of year)
4 Children	X		1-5	X												

(*) Y = Years R = Read W = Write.

Location	Area		Tenure Status			Area in ______			Operated by ___		Legal status of owner	
	Blocks	ha	Own	Rent	Other	Producer	Share Crop	Rent	Abandoned	other	Individual	Other (explain)
a. Princ.	10		X			8	2				X	
b. 1 km	2		X			2					X	
c.												
d.												
e.												
f.												
g.												
h.												
i.												

8. Are there other laborers on the farm? Yes How many? ______

9. What was the maximum number of temporary workers in 1972? ___6___ In which month? November.

10. What is the size and type of tenure of the various plots, lots or parcels included in the operation in 1972? (See table on facing page)

11. Other lands or operations belonging to the producer in 1972:

______

______

12. Land Use, 1972:

Item	blocks	ha
a. Permanent crops	7	
b. Silage		
c. Annual Crops		
d. Fallow		
e. Pasture	5	
f. Forest, hills		
g. No agric. value		
h. Others		
Total farm area	12	

13. Permanent crops:

Crop	Area 1972 blocks	Area 1972 ha	Total No.	Trees in Production
a. Sugar Cane				
b. Coffee	7		?	All
c. Cacao				
d. Bananas				
e. Plantains	2		200	100
f. Grapes				
g. Other fruits				
h.	Interspersed			
i.				

14. Annual crops:

Crop	Area 1972 blocks	Area 1972 ha	Usual Area
a. Corn			
b. Wheat			
c. Barley			
d. Rice			
e. Potatoes			
f. Beans			
g. Cotton			
h. Soybeans			
i. Sesame			
j. Cassava			
k. Vegetables			
l.			

15. Livestock, fowl:

Type	Number, 1972 Now	Number, 1972 Ave.	m^2 of covered buildings
a. Milk cows, 2 years	1		
b. Others			
c. Beef Cattle, 2 years			
d. Others	5		
e. Horses	2		
f. Mules			
g. Pigs, hogs			
h. Fowl	6		
i.			

16. How much area is under irrigation? ______None______

17. Where do you sell your major products?

    On the farm ________ in town __X__ in the city __________

18. Do you sell your important products to:

    retailer? ________ cooperative? __X__ official agency? ______

    directly to the consumer? ______________

19. Do you use a tractor? No ____X____

    Yes, my own __________

    Yes, rented __________

20. Do you use feed concentrates? ____No____

21. Do you use chemical fertilizers? ____No____

22. What changes have you introduced on your farm in the last 4 or 5 years? ______None______

23. What influence have these changes had on land surface and crop production?
    On herd size and production? On the use of labor and machinery? On other aspects of your business? ____________

    ____

    ____

24. Have you considered making any changes in the near future?
    ______Yes______

    Please specify. Replace shaded coffee with unshaded coffee

25. Who provides you with technical assistance? Coffee Federation

26. Have you come into contact with the following sources of information?

    Farm visits __X__ ; meetings ______ ; office visits ________ ;

    publications ______________ ; others ____________________

27. Is this farm the primary source of income for you and your family?

    ______Yes______

28. Have you thought of moving somewhere else? ____No____

    Where? ______________________________

29. Would you be willing to help us develop a broader study of your farm in order to determine how you can increase your income? ____Yes____

Cooperating with specialists to develop input-output information

Efforts to identify and evaluate promising management alternatives generally include acknowledging the shortage of available information on the physical aspects of input-output relationships. In this area, agricultural management specialists must join forces with various other professionals to identify existing useful precedents and add additional knowledge through new research. This type of task should play an important part in the ongoing endeavors of the researcher in farm management.

At the same time, the farm management analyst will need to work with other economists to develop an analysis of the future demand for agricultural products and the supply of inputs.

Evaluating opportunities and trends under the status quo

The next task should be to develop area-wide hypotheses on the implications to be derived from individual case studies and from additional information.

It is easy to see that certain adjustments benefit the whole area as well as individual farms. However, the farmers in the area may have problems if the majority decides to produce great quantities of a product whose demand is very limited.

Evaluating trends and opportunities under alternative institutional conditions.

The analysis of individual farms and on the area level has so far been conducted under the assumption that there will be no change in social institutions.

The next step is to determine what additional benefits will be possible for different types of individuals, and for the public in general, if certain revisions are made in the institutional framework of society. Changes may be necessary in land tenure, marketing institutions, credit contracts and others. At this point agricultural management analysis becomes important for the specialist in agrarian reform, whose task is to study, evaluate and probably execute these institutional changes in the social setting.

Re-evaluating individual cases under alternative technology, price and institutional conditions.

It should be expected that the need to evaluate the conditions presented in the case studies for the individual units will continue to exist as changes take place in technological possibilities, prices and institutional arrangements. This task can be relatively easy, as the initial case studies have already provided the basic information.

THE PARTICIPANTS IN AN INTEGRATED DEVELOPMENT PROGRAM

As has been pointed out, an integrated program for analyzing agricultural management problems can and should include a wide variety of participants. Those who work in agricultural management research should play the central role, but the local extension services, students of agriculture, specialists in various technical fields, economists specialized in prices, and representatives of agencies in charge of carrying out agrarian reform projects, soil conservation and other activities should also be included. All have an active part to play in the program. Finally, individual farms can contribute extensively to the analysis of special case studies.

Those who work in farm management must be aware of the broad applications of their analysis, as well as the relationships they bear with the activities of many other groups involved in agriculture.

SUMMARY

Farm management analysis pursues objectives on two different levels: the producer or individual enterprise and the set of all operations on a regional or national level.

In the former case the objective is to guide individual producers to improve the use of their resources in such a way as to enhance society's well-being. In the latter, farm management analysis provides a fundamental analysis of the efficiency of the combination of resources, thus erecting a foundation upon which to improve public administration in the area of planning agricultural policy and orienting the institutions directly or indirectly involved in agriculture.

In order to understand the role of agricultural management in an economic development plan, it is important to understand that development is more than just economic growth; it implies a reorientation of political and social power, income redistribution and the broad-scale participation of all sectors of the population in the social and political institutions. Economic development programs should be designed to help agricultural enterprises obtain certain desired responses. This means combining and integrating coordination of activities on the local, regional and national levels.

Thus, the contributions of agricultural management as defined herein can serve economic development programs in four specific ways: a) by providing a basis for the development of anticipated plans; b) by providing a guide for planning assistance programs of public institutions; c) by providing a basis for university teaching; and d) by providing a basis for extension programs.

In order for agricultural enterprises to contribute to development plans, incentives must be provided for the campesinos. These incentives include: local availability of critical inputs; credit facilities; favorable price-cost ratios; definition of land tenure conditions; protection against risk; marketing facilities for agricultural products; stimulation and creation of channels for campesino participation; replacing pure, descriptive agricultural management research with research directed toward problem-solving on a socio-economic basis; establishing methods for farm planning; and subdividing national goals onto the local and regional levels.

QUESTIONS

1. Briefly describe how farm management analysis can contribute to economic development programs.

2. Describe the incentives needed for campesinos to contribute to economic development plans through agricultural enterprises.

3. Briefly describe a sequence for the management analysis of an agricultural enterprise.

4. Who are the participants in an integrated program of economic development?

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PART TWO

GUIDE FOR PLANNING THE AGRICULTURAL ENTERPRISE

INTRODUCTION

The previous chapter presented a theoretical framework for the planning and analysis of the agricultural enterprise in the context of agrarian and settlement plans or, on a more general level, for a program of integrated economic development.

In this chapter, we will move into the practical stage, in the form of exercises; that is planning the agricultural firm by means of comparative budgets.*

This section is divided into three chapters that illustrate certain principles useful in the classroom or in field work for agricultural management courses. There is also enough flexibility for the formats to be used by members of agencies for agrarian reform, supervised credit, etc. This can be done by omitting the process of dividing the work into stages and instead conducting the interview by filling out all the forms at once. This requires training and practice, which are indispensable for professionals involved in the work. However, it should be emphasized that no single sequence of stages can possibly provide ideal programming techniques for all situations.

Chapter 8 shows how to obtain data from the agricultural firm. It includes suggestions on conducting the interview, as the ultimate success of planning depends largely on the quality of the data obtained during farm visits. It then presents forms to be used for completing the inventory and the table of farm characteristics. Finally, forms are provided for summarizing data and developing a benchmark plan for the agricultural business. In some cases it will be necessary to design new forms and adapt them to the characteristics of the zone and the particular agricultural enterprise.

(*) The organization and preparation of this section are based primarily on the practica developed by the author for teaching Agricultural Management in the School of Agricultural Sciences of the National University of Colombia in Medellin, and on:

HEDGES, T.R. and SITTON, G.R. *Farm Management Manual: A Guide to Reorganizing a Farm.* Palo Alto, California, the National Press, 1956, 133 p.

Chapter 9 explores the promising alternatives for the agricultural enterprise on the basis of input-output data per hectare and per animal.

Chapter 10 gives the overall analysis of the agricultural enterprise through comparative budgets.

CHAPTER 8

USING DATA ON THE AGRICULTURAL ENTERPRISE AS A GUIDE FOR FUTURE PLANNING

The interview with the farmer and the analysis of records of the agricultural firm are the two most commonly used methods of obtaining data necessary for the re-organization and planning of the enterprise. As was seen earlier, the majority of the farmers in Latin America do not keep accounting records. Consequently, the interview is the most common method of collecting data. In some cases it is possible to use both approaches in a complementary fashion. The formats presented in the following exercises should serve as a guide for obtaining the data necessary for business analysis.

The type of information required for planning the agricultural enterprise can be classified as follows:

- An inventory of the quality and quantity of available physical and human resources;

- A history of recent production activities and of resource use;

- Estimates of future physical possibilities, under various alternatives.

EXERCISE No. 1. THE INTERVIEW*

INTRODUCTION

It is difficult to establish an orderly, schematic set of rules or suggestions for conducting an interview. Those presented below reflect several key points which should be considered.

The first step in any interview is to gain the confidence of the interviewee. It should be clearly stated that the information will be used only for the purpose of studying the farm, and that the interview will be totally confidential. Certain courtesies must not be overlooked, such as issuing a preliminary request for the interview, thus

(*) Croxton and Cowden[2], Lundberg[6], Selltiz[7].

demonstrating a respectful attitude toward the farmer's time, and dressing appropriately for the working environment. An interviewer wearing work clothes will probably be better accepted than one who arrives in coat and tie.

The manner of speaking should be friendly and suitable for the farmer's level of education. The interviewer should show an interest in the farmer's work and a familiarity with the types of farming practiced in the area. It is also wise to remember the general principles of the "steps" of an interview.

OBJECTIVES

a. Plan the survey.

b. Make preparations for acquiring data from the agricultural enterprise.

c. Learn to conduct an interview.

PROCEDURE

Before the interview

1) Visit the area and familiarize yourself with the types of agriculture present. Note the various existing forms of exploitation, the terms used for the various tasks, the land surface and weight measurements used, and other similar information.

2) Clearly define the objectives of the survey and design the questionnaire to achieve these objectives.

3) Discuss the survey with authorities and request their cooperation.

4) Search for and review secondary sources of information available in the zone.

5) Decide which type of study (sampling or case study) is the most appropriate for the conditions of the area, in terms of available funds and personnel.

6) Begin classifying and defining the terms which will be used in the survey, taking into account the information acquired under point 1) above.

7) Compile a list of the farmers in the area and begin to make the selection of interviewees, on the basis of the type of survey to be undertaken.

8) Begin designing a questionnaire on the basis of information provided by local leaders.

9) Prepare a system for tabulating the interview data.

10) Begin testing and correcting the questionnaire.

11) Prepare a set of instructions for the interviewers.

12) Prepare multiple copies of the questionnaire, the tabulation tables, and the interviewer instructions.

13) Hire and train field supervisors as needed.

14) Hire and train interviewers.

During the interview

1) Clearly explain the purpose of the visit.

2) Be prepared to answer questions from the interviewees.

3) Introduce yourself to the interviewees, explain the work of the organization you represent, and briefly explain the purpose of the visit.

4) Show interest in everything the interviewees want to tell you, letting them feel like important participants; however, do not prolong the visit unnecessarily.

5) Be as natural as possible with the interviewees and help them to feel comfortable with you.

6) Use the interviewees' own terminology.

7) Try to gain, hold and deserve the farmers' confidence.

8) Help the interviewees identify with you by citing similar experiences, points of view, likes and dislikes.

9) Ask questions which are easy to answer, but which do not imply certain responses. Avoid loaded questions.

10) Be careful to avoid speaking in an insinuating or rude tone of voice.

11) Let the interviewees think for themselves and give them time to think out their responses carefully.

12) Listen attentively.

13) Try to provide satisfactory responses to any objections.

14) Never try to gain the farmers' cooperation by making specific promises; rather, offer a brief description of how the conclusions of the study can benefit the sponsoring institution and the individual farm.

15) Be alert for the appearance of any major problems directly related to the objectives of the study and not included in the questionnaire.

Controlling the interview

1) Do a mental check for any contradictions in the information provided by the farmer.

2) Assume that any such contradictions are misunderstandings.

Closing the interview

When it is time to conclude the interview, ask whether the farmers have anything to add. Ask: "Is there anything else you would like to mention? " or "Have we covered everything? "

EXERCISE No. 2. RESOURCE INVENTORY AND MAP OF THE AGRICULTURAL ENTERPRISE*

INTRODUCTION

An inventory is a statement of the nature and value of an individual's possessions and debts at a given moment. The purpose of the inventory is to provide a list of capital assets and liabilities and to obtain an idea of the net capital of the business.

Capital assets can be defined as anything of value which is owned by or owed to the business. Capital liabilities are the debts of the

(*) Hedges[4].

agricultural firm. Liabilities are usually classified according to the time period for paying each liability.

The difference between capital assets and total liabilities is net capital.

In order for an inventory to be compiled, it is necessary first to make a physical count of the assets and liabilities of the firm, recording the quantity of each article, such as machinery, feed, etc. and assigning it a value.

While the physical count presents no problems, the assessment of the items is somewhat difficult, and problems can arise.

Appraisal method

Some of the most common methods of appraisal and some of their uses include:

At cost, or the price paid for a given item. This is used to appraise purchased feed and inputs (seeds, insecticides, fungicides, machinery, tools, etc.) and sometimes for land and crops.

At cost less depreciation. This is the price paid for the item, minus depreciation, calculated according to age, price and the condition of the article. It is used to appraise machinery, equipment and buildings.

At market price. Goods are valued according to the prices in the market place at the moment the inventory is taken. This is used to appraise crops, livestock, feed produced on the farm, and inputs.

Average cost during recent years. This involves averaging the prices of the past few years. It is used to appraise land.

Depreciation

Depreciation of a resource represents an expense and/or a decrease in the value of a resource during its useful life. Depreciation is applied to fixed assets, or those which have a useful life of more than one year.

Depreciation of a resource is a cost to the producer and should be figured with other production costs, although the method of calculating it is different from that used for other resources. For example, in the case of seed it is easy to calculate how many kilograms were used during the year and multiply that quantity by its price. This will give the cost. In the case of a tractor, the situation is different, because the machine will be used for many years and in many different activities, and it is not possible to break it down into parts and assign annual costs. It would not be correct to determine the annual cost by saying that the tractor spent X amount of gasoline or tires in one year. Some other method must be found for distributing this expense over the various years of the useful life of the resource.

Several factors affect this expense, defined as the decrease in the value of a resource, and they depend to a certain degree on the useful life of the item.

This, in turn, depends on:

- the amount of annual use (number of hours used);
- the conditions of use (climate, type of soil);
- maintenance (adequate repairs, oil and filter changes, covered parking area);
- the operator (careful handling);
- type of machinery or construction;
- the quality of the machinery or construction;
- producer's plans for exchanging the resource after a certain amount of use.

In addition to losing value through use, a resource can lose value through technological changes. In the case of machinery, new models may do better work, move faster, or provide new types of services, and they often can do so for a lower cost per unit of operation. In the case of constructions, loss of value can be attributed to new production systems and/or to changes in other resources used. A hen house, for example, may become obsolete if new technology develops a preferable type of construction, a different lighting or ventilation system, or better feeding equipment.

Methods of depreciation

There are various methods for determining annual depreciation of a fixed asset. Each has its advantages and disadvantages.

The three most commonly used are: straight line depreciation (constant or linear), sum-of-the-years-digits depreciation, and declining annual balance depreciation.

Although all three methods are acceptable for accounting purposes, the tax regulations of each country influence the final selection of the most feasible method.

All methods require knowledge of the following factors:

- original cost of the asset;
- useful life of the asset according to its assigned use;
- residual or salvage value at the end of the useful life;
- total depreciable cost, equal to the original cost or value less the salvage value.

a. Constant or linear depreciation

Formula:

$$\text{Annual depreciation (A.D.)} = \frac{\text{Original cost less salvage value}}{\text{\# of years of useful life}} = \frac{\text{Total depreciable cost}}{\text{\# of years of useful life}}$$

Example:	Original cost of tractor	50 000 monetary units (m.u.)
	Salvage value	5 000 monetary units (m.u.)
	Useful life	5 years

$$\text{A.D.} = \frac{50\ 000 - 5\ 000}{5} = \frac{45\ 000}{5} = 9\ 000$$

The calculations for all five years are made in the same manner and appear in the following table:

Table No. 8.1. Calculation of straight-line depreciation (hypothetical data).

Year	Original cost. Remaining value at beginning of each year	Annual depreciation	Remaining value at year's end
1	2	3	4
1	50 000	9 000	41 000
2	41 000	9 000	32 000
3	32 000	9 000	23 000
4	23 000	9 000	14 000
5	14 000	9 000	5 000 (salvage value)
Total	–	45 000	–

The original cost less the sum of the annual depreciations during the useful life should be equal to the salvage value.

That is: 50 000 m.u. – 45 000 m.u. = 5 000 m.u.

As can be seen with this formula, all factors are constant and depreciation is the same for all years.

b. Depreciation by the sum-of-the-years-digits method

Formula:

$$\text{Annual depreciation (A.D.)} = \frac{\text{Original cost less salvage value} \times \text{Number of years of useful life remaining at beginning of each agricultural year}}{\text{Sum of the years of useful life of the asset, beginning with 1}}$$

Example: Original cost of tractor 50 000 m.u.
Salvage value 5 000 m.u.
Useful life 5 years
Sum of the digits $\Sigma_1^5 = 1+2+3+4+5 = 15$

$$A.D._{(1)} = \frac{(50\,000 - 5\,000)\,5}{15} = \frac{45\,000 \times 5}{15} = 15\,000 \text{ m.u.}$$

$$A.D._{(2)} = \frac{(50\,000 - 5\,000)\,4}{15} = \frac{45\,000 \times 4}{15} = 12\,000 \text{ m.u.}$$

$$A.D._{(3)} = \frac{(50\,000 - 5\,000)\,3}{15} = \frac{45\,000 \times 3}{15} = 9\,000 \text{ m.u.}$$

$$A.D._{(4)} = \frac{(50\,000 - 5\,000)\,2}{15} = \frac{45\,000 \times 2}{15} = 6\,000 \text{ m.u.}$$

$$A.D._{(5)} = \frac{(50\,000 - 5\,000)\,1}{15} = \frac{45\,000 \times 1}{15} = 3\,000 \text{ m.u.}$$

Table No. 8.2. Summary of annual depreciations by the sum-of-the-years-digits method.

Year	Original cost. Value at beginning of year	Annual depreciation	Remaining value at year's end
1	2	3	4
1	50 000	15 000	35 000
2	35 000	12 000	23 000
3	23 000	9 000	14 000
4	14 000	6 000	8 000
5	8 000	3 000	5 000 (salvage value)
Total	–	45 000	–

The original cost less the sum of all the annual depreciations during the useful life should be equal to the salvage value.

That is: 50 000 m.u. – 45 000 m.u. = 5 000 m.u.

The calculation of the sum of the digits from one through the number of years of useful life is easy when the useful life of the asset is short. When it is not, the following equation should be used:

$$\Sigma_1^n \frac{n\ x(n+1)}{2}$$

where n = number of years of useful life of the asset.

c. **Declining annual balance depreciation**

Formula:

$$\text{Annual depreciation (A.D.)} = \frac{\text{Original cost for first year, and residual}}{\text{cost for remaining years of useful life}} \ \mathrm{x} \ \frac{\text{Rate of}}{\text{depreciation}}$$

Using the same example as above, we assume an annual depreciation of 40 percent.

$A.D._{(1)}$	= 50 000 x 0.40	= 20 000
Residual value at beginning of year	= 50 000 – 20 000	= 30 000
$A.D._{(2)}$	= 30 000 x 0.40	= 12 000
Residual value at beginning of year	= 30 000 – 12 000	= 18 000
$A.D._{(3)}$	= 18 000 x 0.40	= 7 200
Residual value at beginning of year	= 18 000 – 7 200	= 10 800
$A.D._{(4)}$	= 10 800 x 0.40	= 4 320
Residual value at beginning of year	= 10 800 – 4 320	= 6 480
$A.D._{(5)}$	= 6 480 x 0.40	= 2 592
Residual value at beginning of year	= 6 480 – 2 592	= 3 888

Table No. 8.3. Summary of annual depreciation.

Year	Original cost. Value at beginning of year	Annual depreciation	Remaining value at year's end
1	2	3	4
1	50 000	20 000	30 000
2	30 000	12 000	18 000
3	18 000	7 200	10 800
4	10 800	4 320	6 480
5	6 480	(2 592) 1 480	(3 888) 5 000 **(salvage value)**
Total	–	(46 112) 45 000 m.u.	–

Note: In this case the sum of the calculated depreciations is greater than the limit of the total depreciable cost of 50 000 m.u. – 5 000 m.u. = 45 000 m.u. Therefore, it is necessary to adjust the depreciation in the final year such that the value at the end of the fifth year is equal to the residual value. The annual depreciation adjusted in the fifth year is 1 480 m.u., which gives the sum of the depreciation as 45 000 m.u.

The farmer is responsible for deciding which method will be used to calculate depreciation on the basis of the values that are most realistic for this particular business. This means that the method and the calculation of salvage value and useful life for each asset to be depreciated must be carefully selected. Past experience of the farmer or from neighboring farms is often one of the best resources available for making this type of decision.

Two factors helpful in determining the most appropriate moment for taking inventory are whether or not the farmer has free time, and whether or not the harvest is in progress.

The best time for taking inventory is at the beginning of the accounting period. There may be good reasons for taking the inventory at another time of year than January 1. The inventory should occupy only one day of work, but if this is not possible, adjustments should be made for calves born or crops sold (see Form 12).

OBJECTIVES

a. Situate the enterprise in relation to roads, markets, and other characteristics.

b. Prepare the map or sketch of the firm with current soil use and all structures, buildings and other features.

c. Take an inventory and appraise the farm's resources (land, buildings, improvements, machinery and equipment, irrigation system, livestock, labor, etc.).

PROCEDURE

a. Determine and describe the location of the farm.

1) If a base map exists (such as a topographical map of soil ecology) indicate the location on the map.

2) Prepare a sketch showing the orientation and general shape of the farm. Indicate its relation to major roads, towns, etc.

b. Prepare a complete map of the farm as currently used. Indicate all fields, crops, buildings, etc.

c. Take an inventory of resources using the corresponding forms* (Forms 7 to 19 of the agricultural management survey).

Form No. 7. Survey of agricultural management

(Confidential)

Department or Province ______________________________
Municipality ________________ County ________________
Enumerator ____
Date ____
Farm ____________: ____________ km from ______________ on the
highway to ____

1. Who is in charge of this farm?

____
(name)

Owner
Manager
Renter
Sharecropper
Other

(*) The forms included in this chapter provide a framework for guiding the researcher in the type of questions which should be contained in a questionnaire for analyzing and planning the agricultural firm. In many cases it will be necessary to make changes or introduce other forms to help achieve the objective.

2. Who is the producer? ______________________________

______________________ ______________________________

(name) (address)

3. Does the producer keep the records? Yes No

4. Primary occupation ______________________________

5. If renter or sharecropper, who is the owner?

____

(name)

6. How many months did the producer live on this farm in 19___?

____

7. Data on the producer, all persons living in the principal farm dwelling and any of the producer's children who lived in other places in 19___:

Relation to farmer	sex		Age (App)	civil status*				Student	Education**			Worked on farm			Worked off farm	
	M	F		S	M	W	O		Y	R	W	months	days per month	total days	total days	In agric.

(*) S = single M = married W = widowed O = other

(**) Y = years R = read W = write

8. How many other houses are on the property? ____________

9. How many permanent workers on the farm live in these houses? ______________________________

10. How many other permanent workers are employed on the farm? ______________________________

11. During what month did the farmer hire the most temporary labor during 19____? ____________________

    How many? ____________________

12. Size and type of tenure of various fields or plots in the farm unit in 19____:

Location	Area		Tenure status			Area in____			Operated by ____		Legal status of owner	
	Blocks	ha	Own	Rent	Other	Producer	Share crop	Rent	Aban.	Other	Individual	Other (explain)
a.												
b.												
c.												
d.												
e.												

13. Other lands or operations of the producer in 19____:

    a. ____________________

    b. ____________________

    c. ____________________

Form No. 8. Land

Land Use	Initial Inventory		Final Inventory	
	Area	Value	Area	Value
	1	2	3	4
Permanent crops				
Annual crops				
Pasture for cutting				
Permanent pasture				
Total area and value				

Form No. 9. Inventory of current use. Distribution of production

Type of crop	Semester (A-B)	Area in hectares or ___	Number of trees	Production			Quantity used in the enterprise			Sales					Observations on abnormal harvests**
				Yields		% of normal*	For seed	For household consump.	For worker consump.	Quan.	Unit	Price per unit	Total revenue	% to farmer	
				Unit	Quan.										
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

List in the following order: annual crops, semi-permanent (eg. sugar cane) and permanent crops, artificial and permanent pastures.

(*) Indicate reasons for higher or lower yields.
(**) Specify unsold quantities.

Form No. 10. Inventory of machinery and equipment

ITEM	Type	No.	Years on farm	Value		Re-pairs	Purchases		Sales	
				Unit $	Total $		No.	Value	No.	Val-ue
	1	2	3	4	5	6	7	8	9	10
Automobiles										
Pick-up trucks										
Trucks										
Wagons										
Tractor trailers										
Tractors*										
Plow with plowtails										
Plow with 1 plowshare										
Plow with 2 plowshares										
Plow with 3 or more plowshares										
Disk plows**										
Tooth harrows										
Disk harrows										
Seeders										
Rakes										
Planters										
Shellers										
Harvesters										
Overhead loaders										
Fertilizer distrib.										
Hammer mills										
Pumps										
Electrical generators										

(*) Indicate type of tractor (tire, caterpiller, horse power)
(**) Indicate number of disks

Form No. 10 (Cont.)

ITEM	Type	No.	Years on farm	Value		Re-pairs	Purchases		Sales	
				Unit $	Total $		No.	Value	No.	Value
	1	2	3	4	5	6	7	8	9	10
Electrical Equipment										
Sprayers										
Milking Equipment										
Milkers										
Separators (cream)										
Milk bottles										
Pails										
Others										
Equipment for chickens										
Hatchers										
Feeding troughs										
Autom. drinking spouts										
Nests (square)										
(collective)										
Others										
TOTAL										

Form No. 11. Inventory of buildings and improvements

ITEM	No.	Year-end value		Date of construction	Value of construction	Observations
		Unit	Total			
	1	2	3	4	5	6
Farmhouse						
Workers' houses						
Sheds						
Stables						
Corrals						
Fencing (wire)						
Storehouses						
Silos (aboveground)						
Silos (underground)						
Tanks						
Wells, Pumps						
Cooling pools						
Hen houses						
TOTAL						

Value of land

Estimates per hectare (1) Cadastre $ ____________________

(2) Market Value $ ____________________

Has land recently been purchased ____________ or sold ____________?

How much? ____________ What was the price? (3) $ ____________

Form No. 12. Livestock inventory

Type of animal	Number			Value	Purchases during year				Sales during year				Births	On-farm con-sump-tion	Deaths or losses	Obser-vations
	Beg. of year	End of year	Avg.	in $	No.	Age	Price each $	Total cost	No.	Age	Price each $	Total cost				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

Form No. 13. Irrigation system*

a. Gravity flow irrigation systems (controlled flooding)

1) Technical data (Check the appropriate information)

a) Dikes ____________________

b) Furrows ____________________

c) Other ____________________

2) Economic data

a) Annual cost, or rate by volume. Consumption in cubic meters per year ____________________

b) Value per cubic meter $________Total value $________

c) Cost per land unit (hectare or other)$________________

d) Irrigation maintenance cost $____________________

e) Total hectares irrigated__________Total value $________

f) Total value of investment in irrigation infrastructure $______________________**

b. Mechanized systems

1) Technical data (check the appropriate information)

a) Aerial irrigation ____________________

b) Underground tubes ____________________

c) Other ____________________

2) Economic data

a) Total value of investment in irrigation infrastructure $ ____________________**

b) Operating cost $ ____________________

c) Maintenance cost per hectare $________Total $____

d) Amortization cost $ ____________________________

c. Water Source

1) Ground water (check the appropriate information)

a) River __________________________

b) Main Canal ____________________

c) Primary side canal _______________

d) Secondary side canal _____________

e) Intake_____________(number of the intake)________

2) Underground water (wells)

a) File number of the well(s)______________________

b) Average flow in cubic meters per hour_____________

c) Average hours of operation per day during:

lowest demand _________________________

highest demand ________________________

d) Depth of well _________________________

e) Diameter of lining ______________________

f) Characteristics of the pump ______________

g) Type of motor _________________________

h) Power required ________________________

3) Economic data ____________________________

a) Value of investment in wells $ _______________*

(*) Indicate the system and corresponding relevant data.

(**) Copy this information onto Form 23, Comparative Inventory. Background data should be consulted in calculating the benchmark plan and the alternative plans.

b) Cost per 1 000 cubic meters of pumping $__________

c) Estimated annual cost of maintenance and upkeep for the generator $____________________

Form No. 14. Permanent labor

Persons or type of employees	TIME WORKED												Days worked per year	Daily or monthly cash payment $	Benefits paid to farmers as required by law $	Total cash payments during year $
	January	February	March	April	May	June	July	August	September	October	November	December				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

Form No. 15. Hired labor

Contracted jobs (Specify types)	Number of days	Work unit*	Number of persons	Total work units	Amount paid		Cost of benefits $	Total cost $
					Unit $	Total $		
1	2	3	4	5	6	7	8	9
Total								

(*) Task, harvest, etc.

Form No. 16. Farmer's debts.

Type of debt	Pending		Loans during year			Payment during year		
	Beginning of year	End of year	Source	Quantity	% Interest	Payee	Quantity	% Interest
1	2	3	4	5	6	7	8	9
Total debts								

Form No. 17. Accounts Receivable and Monetary Assets

Item	Amount at beginning of year	Amount of annual interest	Amount at end of year
	1	2	3
Debtors Monetary assets: Cash Bank accounts Others (bonds, stocks)			
Total accounts receivable and monetary assets			

Form No. 18. Inventory

ITEMS	Initial inventory			Ending inventory			ITEMS	Initial inventory			Ending inventory		
	Quan.	Unit	Value	Quan.	Unit	Value		Quan.	Unit	Value	Quan.	Unit	Value
	1	2	3	4	5	6		7	8	9	10	11	12
Stored grains and products													
							Fertilizers						
							Crates						
							Gasoline						
							Lubricants						
							A.C.P.M.						
							Drugs						
							Vaccinations						
Construction													
materials							Feed con-						
							centrates for:						
							poultry						
							dairy cattle						
Fungicides							hogs						
Insecticides													
Seeds							others						
							7. Total value inventory						

Note: The word "Unit" refers to tons, sacks, boxes, gallons, etc.

Form. No. 19. Current map of agricultural enterprise

Trace in the size and location of plots.

KEY

Fences	____x____x____	property line	————————
public highway	=========	crop line	——————
road	:::::::::::::::::::	Trees	O O O
constructions		rocks	Δ Δ Δ

EXERCISE No. 3. INVENTORY AND EVALUATION OF SOIL AND LAND RESOURCES*

INTRODUCTION

In order to undertake an inventory and evaluation of soil and land characteristics, the planner should have access to a soil map of the farm, defining the limits and approximate area of the various soil groups. This map should be as accurate as possible, for all possible information on soils must be available if a cropping system is to be devised that can make the best, most appropriate use of different soils during the longest possible time. Surveys conducted by organizations that provide this service generally show series and types of soils broken down into maps with scales of 1:1 500 to 1:20 000. These maps are very helpful for identifying and defining different soil limits.

The Storie Index can be useful for this evaluation. It is based on four factors: soil profile, texture of the upper layer, land slope and other conditions which affect land use.

There are other bases for classification. Soil conservation studies classify soils by their adaptability for various uses. Any system can be useful and beneficial for interpreting physical characteristics. The profile is one of the most important factors considered in soil studies. However, variations in harvests are related to other factors. Therefore, the planner's role is to identify these relationships and use them with good judgement in planning different cropping systems.

OBJECTIVES

a. Obtain data on soil characteristics.

b. Analyze grazing and farming land in terms of the soil characteristics, and determine the physical quality of the fields and plots on the farm.

c. Evaluate the farm according to its ability to produce various crops, to sustain livestock, or for other uses.

(*) Lafaurie[5], Soil Survey Staff[8], Stephens[9], Storie[10].

PROCEDURE

a. On the basis of soil surveys (existing or to be conducted), soil series and types should be identified for the various fields, and any special problem related to topography and land should be described.

   1) Prepare a soil map for the farm plan.

   2) List the various soil groups and identify them on the map by color.

   3) Identify any dominant topographical features on the map and include significant characteristics such as gulleys, rocky outcroppings, etc. (use symbols when the map scale prohibits complete separation).

b. Assess each soil according to the Storie Index (use Form 20).

   1) Classify each soil series and type according to the following factors: soil profile characteristics, texture of the upper layer, and soil conditions such as drainage, salinity, fertility level, acidity, erosion and microcurves.

   2) Assess the value according to this index for each soil series and type as well as for the farm considered as a whole unit.

c. Evaluate the fields and the farm as a whole according to the adaptability of soil for producing crops and livestock (classify as excellent, very good, good, fair and poor).

   1) List the various crops which are most adaptable to the soils on the farm.

   2) Use this data to prepare a brief report on soil management on the farm, indicating the practices which should be implemented to maintain soil productivity, as well as any special management practices which affect costs.

Form No. 20. Evaluation of farm soils.

Soil series type	Fields	Soil Characteristics				Value	Hectares
		Profile	Texture of the upper layer	Slope	Other factors		
1	2	3	4	5	6	7	8

EXERCISE No. 4. INVENTORY AND EVALUATION OF CLIMATIC FACTORS AND WATER NEEDS FOR IRRIGATION*

INTRODUCTION

The farm's irrigation needs must be clearly understood before new and expensive irrigation works can be built. The use of available irrigation water must be adapted to the needs of the land and to the crops which are to be produced.

Data on total water needs, including water for irrigation and for consumptive use, are both appropriate and necessary for making efficient use of modern irrigation techniques.

An inventory and evaluation of the farm's climatic factors are needed for determining the water requirements for crops to be planted. This information on precipitation determines the quantities of water needed for irrigation.

Factors that influence water consumption

Many factors act independently or together to influence the quantity of water consumed by plants. These effects are not always constant, but may differ from one location to another and fluctuate from year to year. Some involve humidity, while others are related to influences of the natural environment.

The most important natural influences are determined by climate, availability of water, soils and topography. Climatic factors which particularly affect consumptive use are: precipitation, temperature, humidity and wind.

Pests, diseases and weeds

Modern agriculture requires at least four types of control: weeds, pests, diseases, and rodents or other forms of animal life.

Problems caused by pests, diseases and weeds have a heavy impact on profits, not only in terms of revenues, but also through expenses. Left uncontrolled, they cause a considerable drop in yields, while if they are controlled, they increase expenditures for inputs (insecticides, fungicides). Some act as limiting factors for a crop or even eliminate production altogether. For this reason the manager should select methods of control on the basis of the goal of maximizing profit.

One of the first steps in planning cropping systems is to review the various types of problems which affect them. Not only should

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(*) Blair[1], Espinal[3].

pests and diseases be identified, but also the degree of infestation should be determined. The same holds true for weeds and various forms of animal life which affect crops and livestock. Also, control systems on neighboring farms should be observed, and the local agronomist or the closest experiment station should be consulted.

Once the farmer understands the most effective methods of control for known pests, diseases and weeds, the relevant costs must be considered for determining net income through comparative budgets.

OBJECTIVES

a. Study the important climatic characteristics affecting the adaptability and potential of agricultural and livestock development.

b. Determine the levels of water available for irrigation; study the effect of irrigation on the selection of crops or on other soil factors affecting production.

c. Identify the most common pests, diseases and weeds on the farm crops.

PROCEDURE

Summarize the major climatic factors affecting agricultural and livestock development in the zone.

a. Prepare a diagram of average monthly precipitation for the farm (Form 21). If no records are available, consult the nearest meteorological station and if possible, average the data for at least the last 10 years (Figure 37).

b. Prepare a diagram of the monthly average temperature for the farm (Form 22). If no records are available, consult the nearest meteorological station and, if possible, average the data for the last 10 years (Figure 38).

Consult publications providing meteorological data for the area, and find precipitation and temperature data for a. and b.

Form No. 21. Average monthly precipitation for the farm (cm).

Months	J	F	M	A	M	J	J	A	S	O	N	D
Precipitation (cm)												

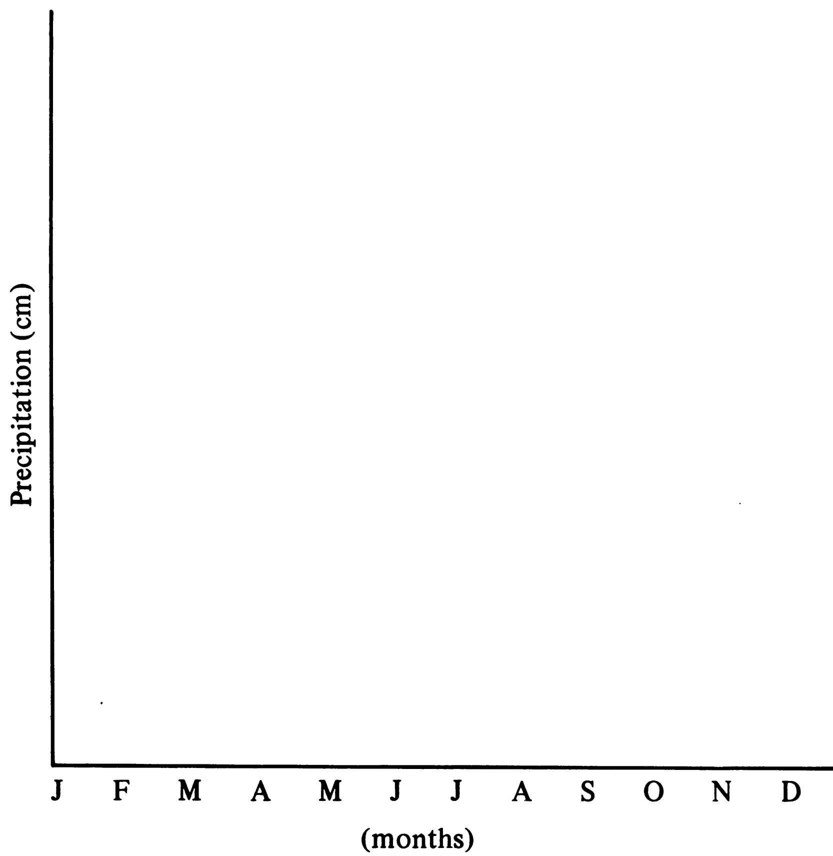

Fig. No. 37. Average annual precipitation. Data for ______ years.

Form No. 22. Mean monthly temperature

Month	°C.
January	
February	
March	
April	
May	
June	
July	
August	
September	
October	
November	
December	

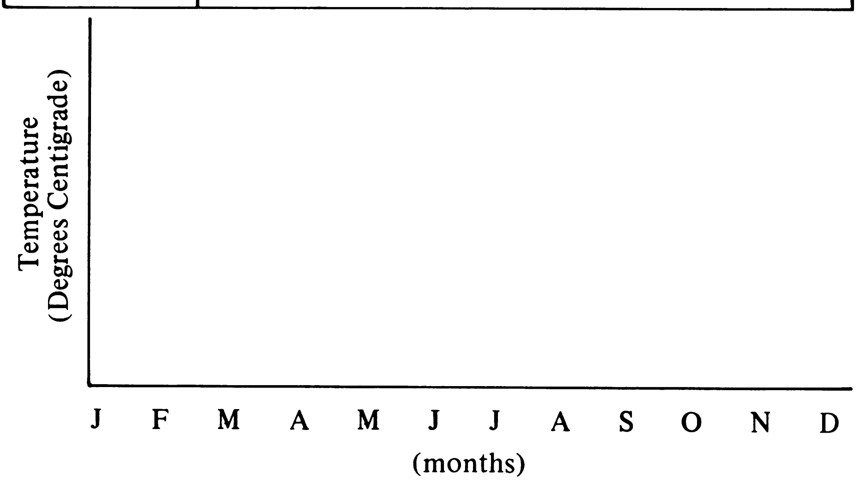

Fig. No. 38. Average annual temperature. Data for______years.

c. Evaluate irrigation needs and possibilities on the farm (see Form 13). The following questions should be answered:

1) How much water is pumped from existing wells?

Maximum use ________________ Minimum use ___________

2) What is the pumping capacity of these wells?

Maximum use ________________ Minimum use ___________

3) Approximately how many hectares of crops that need irrigation can be irrigated with this water? ____________________

4) How many hectares can normally be irrigated? ______________

With additional irrigation? __________ Total ______________

5) Does presently existing irrigation water cover current needs? ____

6) How adequate and effective is the current system of wells and canals? ______________________________________

d. In the case of sprinkler irrigation, consult point a., or consider the following factors:

Application began at ______ o'clock and ended at _____ o'clock.

Duration of application____________________

Duration of wind _____________ Relative velocity ___________

Temperature _________________ Relative humidity___________

Main line pressure on the pump ____________________________

At the end of the line ____________________________________

Observation on degree of water application ________________

Operation: number of positions of lateral lines to cover the entire field ______ ____

Number of positions per day _______________________________

Number of laterals operating simultaneously ________________

Number of hours which laterals operate per day ______________

Time needed to move laterally ___________________________

Number of sprayers operating simultaneously ________________

e. Prepare a list of pests, diseases and weeds most commonly affecting crops and livestock on the farm.

Answer the following questions:

1) How much damage is caused by each pest, disease or weed?

2) What are the recommended means of control?

3) What is the annual cost of controlling the major pests, diseases and weeds on the farm?

4) Answer 1), 2) and 3) above for farm livestock.

EXERCISE No. 5. CALCULATION OF NET INVENTORY VALUES

INTRODUCTION

After completing the physical inventory and appraising each item or group of items included, total all the different values of the inventory items to find their net value.

In order to calculate the net inventory value, assets are generally categorized by function in the agricultural firm. The grouping can be based either on the product lines that use the assets, or on the objectives of the assets with respect to other businesses. This method makes it possible to identify significant relationships in the use of the various resources. The items are generally classified as fixed assets, current assets or liquid assets. This classification is based primarily on the life of the resource.

OBJECTIVES

Calculate net inventory values and determine inventory increases or decreases.

PROCEDURE

a. Calculate the total value of the various items and find the totals in the corresponding columns of Forms 8-18.

b. Copy the figures onto Summary Form 23.

c. Write a summarized statement of the financial situation of the farm. Use all the forms already mentioned.

d. If the data are available, make inventories for one or two previous years and compare them. Use columns 4, 5 and 6 of Form 23.

EXERCISE No. 6. OBTAINING DATA FOR ANALYSIS OF THE AGRICULTURAL ENTERPRISE

INTRODUCTION

It would be impossible to construct an exhaustive list specifying the types of data useful for planning various kinds of farms in Latin America, or any given region. Each crop, machine, animal or unit of resources has a definite function under certain conditions, in combination with specific other resources. It is important to understand all these possibilities of behavior for the planning process. Equally important is information about markets and future trends. As a consequence, these forms will be only a guide for obtaining data and making a subsequent analysis.

OBJECTIVES

To train students to prepare forms and conduct interviews.

PROCEDURE

a. Prepare and reproduce the forms needed on the basis of the above examples in Forms 24 to 32.

b. Prepare instructions for filling out questionnaires. Be sure the interviewer clearly understands the purpose and intent of each question.

c. Make a repeat visit to the farm and obtain information concerning the farm's activities during the last agricultural year.

Form No. 23. Comparative inventory.

Asset	Form & Column	Value beginning of year	% of total capital	Form & Column	Value end of year	% of total
	1	2	3	4	5	6
CURRENT						
Land	8-5					
Buildings, improvements	11-4					
TOTAL FIXED						
CURRENT						
Beef cattle	12-5*					
Horses	12-5					
Tractors	10-5					
Equipment	10-5					
Total value of irrigation infrastruct.	13*					
TOTAL CURRENT						
LIQUID						
Fattening calves	12-5					
Hogs	12-5					
Hens	12-5					
Grains, products stored	18-6					
Total value fungicides, fertilizers	18-12 (last line)					
Accounts receivable, money in bank	17-2-4					
TOTAL LIQUID						
TOTAL CAPITAL			100			100
LIABILITIES						
Mortgages	16-8					
Notes payable	16-8					
Accounts pay.	16-8					
Others	16-8					
TOTAL LIAB.						
NET CAPITAL						

(*) Line-by-line data should be copied here, rather than totals, as inventory is being distributed as fixed, current and liquid assets.

Form No. 24. Seeds, fertilizers and other materials used on crops.

Crops	Ha. or ——	Seed Used								Fertilizers					Fungicides, insecticides, etc.					
						Purchases				Purchases					Purchases					
		Quan. per unit	Unit	Total Quan.	% of farm	Quan.	Unit Price	Total Spent	% to farm	Quan. per ha	Ton	Unit Price	Total Spent	% to farm	Type	Quan. per ha	Kilos	Unit Price	Total Spent	% to farm
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21

Form No. 25. Summary of other cash expenditures for the agricultural firm.

Type of Expenditure	Quantity	Unit	Weight per Unit	Unit price	Total Expenditures
	1	2	3	4	5
Cattle feed, forage					
Gas					
Oil					
Grease					
Tires					
Food purchased for workers					
Vaccinations and veterinary drugs purchased					
Veterinarian					
Tools					
Wire					
Transportation					
Taxes					
Land rental					
Interest paid					
Others					

Form No. 26. Interest, taxes, insurance and cash rental.

Item	Paid by farmer	Paid by owner*	Total paid
	1	2	3
Loan interest			
Taxes			
Rent (Machinery, equipment)			
Rent (animals)			

(*) When other than the farmer.

Form No. 27. Use of livestock and poultry products on the farm.

Item	Use for live-stock, poultry, etc.	Consumed in home	Paid to workers
	1	2	3
Milk			
Cheese			
Butter			
Eggs			
Chickens			

Form No. 28. Livestock and poultry income.

Month	Milk				Eggs				Chickens, Cheese, Cream, etc.			
	Production	Quantity Sold	Unit Price	Total Value	Production	No. Sold	Unit Price	Total Value	Production	Quantity Sold	Unit Price	Total Value
1	2	3	4	5	6	7	8	9	10	11	12	13
Year												

Form 29. Other income received from the farm and from the family.

(monetary units)

a. Pasture rental ______________________ ____________

b. Sale of wood, firewood, etc. ___________ ____________

c. Other income from the farm ___________ ____________

d. Off-farm employment: ________________ ____________

agricultural by producer ______________ ____________

non-agricultural by producer __________ ____________

non-agricultural by family ___________ ____________

e. Others sources of family income _________ ____________

Form No. 30. Fertilization and use of lime.

Fields	Area (ha)	Current Use	Type of farming	Rate of fertilization per ha.	Total hectares fertilized	Yields	Observations
1	2	3	4	5	6	7	8

Form No. 31. General management

a. Where are the major products sold? on the farm________________

locally ________________________ in the city __________________

b. Most sales are to: a retailer____________________________________

a cooperative __________________ an official agency ____________

directly to the consumer_______________________________________

c. What changes have been introduced on the farm during the last 5 years? ____

____

d. What influence have these changes had on crop area and production? On the scale of cattle and livestock production? On the use of labor and machinery? On other aspects of the business? ______

____

e. Have you considered making some change in the near future? ____

____

Please specify____

____

f. Who provides you with technical assistance? ____________________

____

g. What contacts have you had with the following sources of information?

Farm visits ____

Meetings____________________________ Office visits _______________

Publications ______________________ Others ________________________

h. Which sections are under irrigation?___________________________

i. Is this farm the principal source of income for you and your family? ____

j. Have you thought of moving away? _____________________________

Where? ____

Form No. 32. Land use, crop and livestock yields.

BENCHMARK PLAN __________ ALTERNATIVE PLANS________

FARM __________________________

ITEM	Plan for 19__	Benchmark	Plan I	Plan II
Land use		(hectares)		
______________				
Crops		Yield (kilos per hectare)		
______________				
Livestock: Cows		(number of animals)		
______________				
______________				
Milk production per cow		(liters per year)		
______________				
Poultry: Chickens Hens		(number of animals)		
______________				
______________				
Egg production		(number of units)		
______________				
______________				
Chick production		(number of units)		
______________				
______________				
______________				

EXERCISE No. 7. DEVELOPMENT OF BENCHMARK PLAN

INTRODUCTION

It is necessary to have some point of comparison for planning changes in a farm and improving profitability, or for establishing a new enterprise. In the former case, the operator or farmer should learn to compare the various future alternative plans with a benchmark plan based, at least partially, on past experience. In the case of a new enterprise, no benchmark plan is available, and the operator must compare the outlook for the future business under different alternative plans.

The description of a plan based on experience should include the following factors:

a. Analyze the farm under normal conditions. Do not consider those situations which are beyond the farmer's control, such as: epidemics, price changes, or climatic changes (droughts, rains).

b. Select the principal activities of past plans which are expected to continue in the future.

c. Estimate the physical quantities of inputs and yields which can be expected from the key activities and operations selected in b.

d. Calculate net income, using Form 34.

OBJECTIVES

a. Provide experience in developing a benchmark plan.

b. Provide guidelines for identifying alternatives which should be considered in enterprise and home planning.

PROCEDURE

a. Review the questionnaire and make sure the data are complete. Scale down the units of area, weight, etc. Make another visit if necessary.

b. Calculate farm income and costs. Extract the data on revenue and costs from the appropriate forms, following the guide in Form 33. Place these values on Form 34.

Form No. 33. Summary guide of variable income and expenses.

Income and expenses	Form	Column	Values
Income			
Crop sales	9	14	
Livestock sales	12	13	
Livestock product income	28	5,9,13	
Other income	29	a,b,c,d,e	
Other income (equipment sales)	10	10	
______________			
______________			
Expenses			
Machinery, equipment repairs	10	6	
Machinery, equipment purchases	10	8	
Livestock purchases	12	9	
Permanent labor	14	17	
Contracted labor	15	9	
Debts	16	8	
Seed purchases	24	9	
Fertilizer purchases	24	14	
Fungicide and insecticide purchases	24	20	
Other cash expenditures	25	5	
Interest, taxes, insurance and cash rent	26	3	
______________			
______________			

Note: Use forms similar to No. 2 and No. 3 in Chapter 6. Try to identify alternatives which should be considered in farm and home planning.

Form No. 34. Comparative financial summary for the benchmark plan of the agricultural firm ______________________

	Plan 19____	Benchmark Plan
Major features of each plan		
GROSS REVENUE:		
Crops		
Milk		
TOTAL		
EXPENSES:		
Permanent workers		
Contracted workers		
Seeds		
Fertilizers		
Chemicals		
Livestock feed		
Fuel		
Animal purchases		
Veterinary service		
Drugs		
Building repairs		
Machinery repairs		
Taxes		
TOTAL		
NET INCOME		

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CHAPTER 9

INDICES OR COEFFICIENTS FOR ANALYZING ALTERNATIVE PRODUCTION LINES

Every farmer must decide what crops to plant and what types of livestock to produce. Some decisions, such as when to plant, how to use fertilizer, what type of livestock to raise and other similar factors, can be determined according to local custom based on fundamental knowledge of agronomic, technological and economic principles applicable to each special case. However, the original decisions on production lines, crops or activities depend not only on the size and type of farm and on the productivity of the soil, but also on the quantity of labor available. Also, costs of launching an activity, probable prices of the product when it is ready to be sold, marketing facilities and other economic factors are important. The consideration and evaluation of these factors should be made on practical bases, comparing the economic advantages and disadvantages of each factor separately and as a whole before making a decision.

THE COMBINATION OF PRODUCTION LINES

The profits of the agricultural firm are not determined by extra income derived from some special activity. The ultimate measure of profit or loss for a year of operation is net income for the farm as an integrated operation. Few farmers are located in regions that provide comparative advantages great enough to devote the farm to a single exclusive product. Land is not uniform on the farm; some parts are appropriate for pasture, others for crops, etc.

Each farmer's objective should be to develop an appropriate combination of activities which provides maximum profits in terms of net income in all years of economic operation. This requires consideration of certain factors such as economic use of labor, machinery and equipment, etc. The ideal combination maintains soil productivity and maximizes net income. The next step is to identify complementary activities for reducing costs or increasing yields; supplementary activities should then be identified to improve the use of resources, increase income and maintain the productivity of the farm. The administrative decisions required to select the most suitable activity cannot be made in the absence of a broad knowledge of the product lines and the relative intensity of production.

The indices or coefficients developed in the following exercises can be used as a basis for decisions concerning the selection and combination of activities. The method consists of establishing the relative profits of different farm activities by determining variable unit costs for each activity. Then an analysis of the combination of activities can be done in view of the preferences and aspirations of the farmer.

The use of these indices is subject to certain limitations, and therefore it is difficult to calculate them accurately. Nevertheless, it is a method which can help planners draw up a general farm plan in an orderly fashion. It should be emphasized that the final sucess of any agricultural firm depends on the relationships between the combined production of all useful products and the combined use of all scarce resources.

EXERCISE No. 8. DETERMINING THE RELATIVE PROFITABILITY OF DIFFERENT ACTIVITIES*

INTRODUCTION

As was noted, profit maximization may not be the farmer's only goal. However, we will assume for this exercise that it is. This gives a special importance to determining the relative profitability of each activity for management analysis. It should be recalled that the final decision on the farm involves socio-economic, technological, and agronomic considerations, especially involving the aspirations of the farmer and the family.

OBJECTIVES

a. To develop basic information needed for choosing and combining activities for maximum profit. This analysis includes determining the profitability of different operations under various normal conditions.

b. To organize the alternative activities according to profitability.

c. Using comparative budgets, to evaluate the profits of the alternative activities in accordance with the economic and physical conditions of the farm.

(*) Hedges and Sitton[6].

PROCEDURE

a. Determine the total variable cost per hectare of the alternative activities.

   1) Determine the crop alternatives according to available information on farm resources, the area, and technological and price considerations. Select inputs, yields and costs according to available information.

   2) Make a list of physical production and variable costs for each crop (Form 35). Identify reference sources for all cases. Express the units of measure: machine-hours, worker-hours, kilograms, dollars etc. Determine the total variable cost expected for each crop as given on the last line of columns 3, 5, 7 and 9 of Form 35.

b. Determine gross income per hectare of each crop (use Form 36 for the calculations).

   1) Make a list of expected yields for each crop.

   2) Multiply expected yields by present prices to obtain gross income for each crop. Use future prices if feasible.

c. Calculate expected profits per hectare for each crop.

   1) Fill in columns 1, 2, 3 and 4 of Form 36 with pertinent data from Form 35. Determine the price of each item and place it in column 4 of Form 36.

   2) Transfer the total variable cost of each crop in Form 35 (last line of columns 3, 5, 7 and 9) to column 6 of Form 36.

   3) Calculate gross income by multiplying expected yield by present price or, if available, by future price.

   4) Subtract the total variable cost from gross income and note the result in column 7 of Form 36 (column 5 minus column 6 = column 7)

   5) Establish a priority listing of crops according to net income. Use column 8 of Form 36 to rate the results in terms of 1, 2, 3, etc.

d. Prepare a brief summary to identify and analyze the principal problems and possibilities of the farm in order to make alternative plans.

Form No. 35. Production inputs and variable costs per hectare for alternative product lines.

INPUTS	Unit	Cost per unit	ALTERNATIVE PRODUCT LINES (Crops and Livestock)							
			Cotton		Corn		--		--	
			Quantity	Cost $	Quantity	Cost $	Quantity	Cost $	Quantity	Cost $
		1	2	3	4	5	6	7	8	9
TASKS										
Machinery	machinery hours									
Plowing										
Raking										
Planting										
Tilling										
Earthing										
Fumigating										
Harvesting										
Transporting										
Labor	man-hours*									
Tractor driver										
Planting										
Weeding										
Spraying										
Harvesting										
Milking										
Materials	kg/ha									
Seed										
Fertilizers										
Insecticides										
Herbicides										
Boxes, sacks										
Storage										
Concentrates										
Drugs										
Other expenses	Dollars									
Taxes										
Pasture rental										
Membership dues										
TOTAL										

(*) Worker – days may also be used.

Form 36. Net income per hectare for alternative farm production lines.

Crop or livestock product	Unit of yield	Yield	Price $	Gross income (3 x 4)	Total variable cost	Net income variable cost (5-6)	Order of priority
1	2	3	4	5	6	7	8

1) List the principal problems which must be considered in selecting each activity.

2) Discuss possibilities for change and the problems which would accompany each change. Consider the use of available resources, future prices, loans and possible investments.

EXERCISE No. 9. PLANNING THE USE OF LABOR

INTRODUCTION

The need for manual labor varies widely for the different agricultural products. At the same time, mechanization simplifies tasks and increases yields per man-hour for many general crop and livestock tasks. However, it also produces a displacement of labor toward the cities and toward other rural activities. Nevertheless, labor continues to be an important factor of production and, therefore, affects farmer income.

Decisions on the use of labor require studies on the following:

a. Factor-product relationships, since labor frequently constitutes a high cost item. It is also necessary to study the sources of labor (the farmer and the farm family, regular wage-earners and contracted labor) and its relation to fixed and variable costs and ultimately to income.

b. The factor-factor relationships, because of the replacement of manual labor with mechanical or animal power.

OBJECTIVES

a. To determine labor requirements for planned cropping systems and types of livestock operations.

b. To conduct an analysis of required tasks, when they should be undertaken, and how much specialization is required.

c. To determine potential sources of labor according to the requirements of the agricultural firm, considering not only the regular labor force (in residence on the farm, wage-earning, and working all or part of the year), but also the labor force which works by contract.

d. To estimate the cost of different types of tasks according to their present value, including direct payment to the laborer and any additional or complementary payments.

PROCEDURE

a. Determine regular labor needs for the farming unit, including any tasks required for only part of the year (Form 37).

   1) Determine the permanent labor force by month, for each crop and specialized task. Obtain annual totals by adding each of these items.

   2) Determine the monthly work force for livestock operations and obtain a yearly total (use a table similar to that in 1).

   3) The information should be compiled by hours of work per month and converted to man-days for determining totals for each activity. Eight hours is the legal equivalent of one man-day; it should be understood that on many farms the workday can vary. Calculate the man-equivalent or the man-year for each crop and for the whole farm.

b. Prepare a table similar to that used above. Determine the labor requirements which, while not a part of the permanent work force on the agricultural unit, are needed at certain times of the year (seasonal labor) as well as labor required for special tasks. Follow the same steps described earlier.

c. Determine the family work force for the benchmark plan and alternative plans. Use the bottom section of Form 38 for making calculations. The values included under column 3 are only for purposes of comparison and in no way enter into the calculations of net income. Follow the same procedure described above.

d. Determine wage expenses for permanent workers, including funds for any extra or complementary payments; likewise, determine the value (imputed, if necessary) of the family labor force (see Form 38).

   1) Prepare a list of expenses for wages and additional and complementary payments for permanent and seasonal workers. Include this list in columns 4, 5 and 6. These three columns may be left blank depending on needs. The sum of columns 5 and 6 will give total additional expenditures. The grand total can be found by adding columns 4 and 7.

   2) Prepare a list of imputed values for the work of each family member. It should be recalled that each of the tasks for family members is worth the cost of these same tasks undertaken by

Form No. 37. Work force: farm requirements, benchmark plan and alternative plans.

PERIOD	CROP AND AREA														
	*		*		*		*		*		*		Total man-hours needed	Total man-days**	Man-equivalent***
	Per ha	Total	Per ha	Total	Per ha	Total	Per ha	Total	Per ha	Total	Per ha	Total			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	MAN-HOURS														
January															
February															
March															
April															
May															
June															
July															
August															
September															
October															
November															
December															

(*) Fill in the crop in the corresponding spaces.
(**) Man-day is defined as the work done by one man in 8 hours under normal conditions.
(***) Man-equivalent is defined as the work done by one man in 300 man-days.

Form No. 38. Wages and additional or complementary payments for paid labor; imputed value of family workforce. Benchmark plan and alternative plan.

A. TYPE OF PAID LABOR	Number of workers	Months worked	Wages by job	Annual total of wages	Additional exp.		Total additional (5+6)	Total expenses
					Social security	Others		
	1	2	3	4	5	6	7	8
BENCHMARK PLAN PERMANENT								
1								
2.								
3.								
4.								
5.								
6. SUBTOTAL			XXX					
SEASONAL								
7.								
8.								
9.								
10.								
11.								
12.								
13. SUBTOTAL								
14. TOTAL LABOR								

B. UNPAID FAMILY LABOR	BENCHMARK PLAN			ALTERNATIVE PLAN		
	Type of activity	Months	Value	Type of activity	Months	Value
15.						
16.						
17.						
18.						
19.						
20. SUBTOTAL						
21. TOTAL FAMILY						

wage earners (use the lower part of Form 38 for calculations). The data in part B of Form 38 is not used to calculate net income.

EXERCISE No. 10. PLANNING MACHINERY AND EQUIPMENT NEEDS AND COSTS

INTRODUCTION

The use of machinery and equipment on the farm affects profits and the possibility of increasing them. The use of machinery and equipment involves considerable changes in the organization and management of the agricultural firm. Therefore, the decision about its use should be based on a careful evaluation of the farm as a whole. In order to make these decisions, it is necessary to consider at least three economic relationships:

a. **Factor-product relationships.** Machinery is one of the inputs making up the total cost of production and affecting the income of the farmer and the family. Therefore, in addition to the cost of machinery, thought should be given to the aspects of total cost, fixed costs, variable costs and the relationship of costs to income.

b. **Factor-factor relationships.** It is evident that mechanization displaces labor. This replacement of one factor by another involves comparing the costs of machinery use with those of manual labor.

c. **The use of capital and the time factor.** The use of machinery and equipment generally implies large investments of fixed capital. This in turn requires loans, necessarily requiring time for amortization and interest. Before making these decisions, the farmer should determine whether it is more economical to buy machinery or to rent it. This can be done by comparing the problems, possibilities and costs of the two alternatives.

OBJECTIVES

a. To examine the benchmark plan and the alternative plans for horsepower, heavy machinery and equipment requirements for the field tasks needed under various crop programs.

b. To study the benchmark plan and each of the alternative plans and determine initial investments and annual costs per unit of power (tractors) and other types of machinery.

PROCEDURE

a. Form 8, 10 and 26 are the basis for this exercise.

b. Determine monthly tractor-days required for each crop. Add the figures to obtain total tractor-days necessary for one year (Form 39).

Form 39. Tractor work-days and hours required by crop. Total hours and days to carry out farm plans.

PERIOD	CROP AND AREA														
	*		*		*		*		*		*		Total Machine-hours on farm	Work days available**	Total ***
	Per ha	Total	Per ha	Total	Per ha	Total	Per ha	Total	Per ha	Total	Per ha	Total			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
MACHINE – HOURS															
January															
February															
March															
April															
May															
June															
July															
August															
September															
October															
November															
December															

(*) Specify the crop in the corresponding spaces.
(**) Days the climate and soils permit machine operation.
(***) Number of ten-hours days (hours needed for service and operation) necessary to complete the total number of hours required by farm.

1) Consult the appropriate reference sources to determine requirements by machine-hour for each crop included in the benchmark and alternative plans.

2) Calculate monthly machine-hours, multiplying the figures obtained from the reference tables (see a.) by the total hectares for each crop.

3) Estimate total workdays per month. Determine the number of ten-hour workdays required per tractor to carry out the required tasks stipulated for each month of the year (total columns 2, 4, 6, 8, 10 and 12 of Form 39 and place the result in column 13). Use these figures to determine the number of tractors needed for the farm.

4) Determine the number of vehicles (pick-ups, trucks), harvesters, balers, etc. required under the different plans.

5) Calculate the initial investment and annual costs for the above equipment.

c. Determine the variable costs (direct) for the use of tractors, vehicles, harvesters, balers. Use Form 10 and prepare additional figures for new equipment.

1) The total number of hours of tractor use on the farm can be found in Form 39. Calculate the expenses incurred under normal conditions for repairs, lubrication, oil and gas (use Form 10 as a guide).

2) Use the cropping plan to determine how much service time will be required for machinery, such as harvesters and balers; likewise, use current quantities and prices to calculate expenditures for repairs, lubrication, oil and gasoline.

3) Estimate the number of kilometers or hours of service the vehicles should provide. Use current prices and quantities to calculate the variable expenses incurred for rolling stock (jeeps, trucks).

4) Make the necessary calculations to determine expenses per unit of service (kilometer or hour) of rolling stock.

EXERCISE No. 11. PLANNING IRRIGATION: DETERMINING FACILITIES, INVESTMENTS AND ANNUAL COSTS

INTRODUCTION

When a producer is interested in introducing irrigation into the farm or increasing the area under irrigation, a careful study should be made of the expenses involved and the potential profits brought about through increases in total production, productivity or both.

Certain very important decisions must be made when increases in income are sought through the use of irrigation. They include changing methods of cropping and proportions of resources, and it should be recalled that irrigation requires considerable capital investments.

Well-planned irrigation provides numerous advantages for the producer

If this analysis of the pros and cons of irrigation leads to a positive decision, the following advantages can be expected:

a. Greatly reducing production risks and ensuring uniform yields.

b. Including a greater variety of crops adaptable to the area, opening the way to crop rotation.

c. Using labor, resources and other production factors which otherwise would remain idle.

d. Increasing total income per hectare (related to point a.).

e. Increasing the volume of business through higher and more uniform yields.

Factors which go into making the irrigation system a success

a. The physical characteristics and fertility of the soil should be appropriate for intensive use.

b. The producer should have additional capital or credit to invest in irrigation equipment and in preparing the soil for irrigation.

c. Because operations using irrigation are more market-oriented, they should have a good administrative organization. This will enable the enterprise to overcome its financial problems during difficult periods.

d. To obtain desired income, new technology must be introduced, requiring a more skilled labor force.

e. After installing the irrigation system in order to increase production, the farmer will need to search for new product markets.

f. Because irrigation increases the capital invested in a broad range of problems and decisions, the farmer will need greater administrative capabilities.

Some definitions

According to Blair[1], water requirements to plants are understood as the amount of water needed to produce a given harvest: the net volume of water in addition to rainfall which is needed for crop production. In other words, it represents the quantity of irrigation water which should be stored in the root zone in order to satisfy the water consumption needs of the plant. Total irrigation water includes the net volume necessary, plus the water lost through the application and operation of the system. (taken from U.S.D.A. Soil Conservation Service[9]).

Consumption levels, according to Field as quoted by Luque[7], can be defined as "the amount of water consumed or spent in a given area per unit of time, due to evaporation from the soil and to crop transpiration, integrated to a certain extent with precipitation received by the vegetative cover." Since the amount of water used in the formation of plant material is small in relation to the process of evapotranspiration, consumptive use can be assumed as very similar to evapotranspiration levels if the necessary conditions are present.

Transpiration is the movement of water from the soil to the air through plant growth (Blair[1]).

Evaporation is the diffusion of water as vapor from the soil surface into the atmosphere (Blair[1]).

OBJECTIVES

a. To determine the quantity and distribution of irrigation water required for the benchmark plan and the alternative farm plans.

b. To estimate the initial and annual costs of the irrigation projects in the benchmark plan and the alternative plans.

c. To determine the variable and total costs of the irrigation project.

PROCEDURE

There are various methods of determining the consumptive use, net depth of coverage and irrigation requirements at the field level (1 hectare) and the agricultural firm level (see bibliography). The following exercise is a summarized description of the Blaney and Criddle method[2] as modified by de la Loma[4] and Luque[7].

a. The average monthly temperature in Centigrade for the zone where the farm or area is located (see exercise 4) is obtained and placed in column 1 of Form 40, which will be used throughout the exercise.

b. Since the method described herein was designed for the United States, the temperature is expressed in Farenheit. Therefore, the method should be adapted to another unit of measurement for arid zones. The equation

$$tc = \frac{t + 17.8}{21.8}$$

gives the necessary adjustments for reading the temperature directly in Centigrade. The factor Kt is an additional element included by technicians from the Secretariat of Water Resources of Mexico. The corresponding values appear in Table 9.1 for different average temperatures. The values of tc obtained from the table are placed in column 3 of Form 40.

c. The value "p" (insolation or solar radiance) is obtained from Table 9.2 for southern latitudes and from Table 9.3 for northern latitudes. Using this latitude information for the zone, select the monthly value of "p" from the corresponding table. The values can be interpolated if necessary. The information is placed in column 4 of Form 40.

d. The factor of monthly consumptive use (f.c.u.) is calculated by multiplying the "p" from column 4 by the "tc" values from column 3, or f.c.u. = tc x p. The results are placed in column 5. As can be seen, this views potential consumptive use as a function of climate. The crop factor has not yet been considered.

e. The values of the constant crop factor K are selected from Table 9.4 and placed in column 6. This factor refers to the consumptive use requirements determined by crop conditions. The original studies of this constant were conducted in Texas (El Paso), and

Form No. 40. Consumptive use, net depth of coverage or irrigation requirement. Blaney and Criddle. Procedure modified by Luque[7].

MONTHS	Average monthly temper-ature	$tc = Kt\frac{t + 17.8}{21.8}$	Insolation or solar radiance "p"	fcu = tc x p (potential C.U.) cm	Crop factor "K"	Crop C.U. fcu x K x 10 mm	Effective precipitation (0.80 p) mm	Net depth or replacemt. level (C.U.–0.80 P) mm
	1	2	3	4	5	6	7	8
January								
February								
March								
April								
May								
June								
July								
August								
September								
October								
November								
December								
ANNUAL								

TABLE No. 9.1. Values for the equation $Kt = \frac{t + 17.8}{21.8}$ with average temperature in °C. Luque[7].

°C	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
7......	0.520	0.526	0.531	0.537	0.543	0.549	0.554	0.560	0.566	0.572
8......	0.558	0.584	0.590	0.596	0.602	0.608	0.614	0.620	0.626	0.632
9......	0.638	0.645	0.651	0.657	0.664	0.670	0.676	0.682	0.689	0.696
10......	0.702	0.708	0.715	0.722	0.729	0.735	0.742	0.748	0.755	0.762
11......	0.768	0.775	0.782	0.789	0.796	0.803	0.810	0.817	0.824	0.830
12......	0.838	0.845	0.852	0.859	0.866	0.874	0.880	0.889	0.895	0.902
13......	0.910	0.917	0.925	0.932	0.939	0.947	0.954	0.962	0.970	0.877
14......	0.985	0.992	1.000	1.008	1.016	1.024	1.031	1.039	1.047	1.055
15......	1.063	1.071	1.079	1.086	1.095	1.103	1.111	1.119	1.127	1.135
16......	1.143	1.152	1.160	1.168	1.175	1.185	1.193	1.202	1.210	1.210
17......	1.227	1.235	1.244	1.253	1.262	1.270	1.279	1.287	1.296	1.305
18......	1.313	1.322	1.331	1.340	1.349	1.357	1.367	1.375	1.385	1.393
19......	1.403	1.412	1.421	1.430	1.439	1.448	1.458	1.467	1.476	1.485
20......	1.495	1.505	1.513	1.523	1.533	1.542	1.551	1.561	1.571	1.580
21......	1.590	1.600	1.609	1.619	1.629	1.639	1.648	1.658	1.668	1.678
22......	1.688	1.598	1.708	1.717	1.728	1.738	1.748	1.758	1.768	1.779
23......	1.789	1.800	1.810	1.820	1.830	1.840	1.856	1.860	1.871	1.852
24......	1.892	1.903	1.914	1.924	1.935	1.945	1.956	1.968	1.977	1.988
25......	1.999	2.010	2.020	2.031	2.042	2.053	2.064	2.075	2.086	2.096
26......	2.108	2.119	2.130	2.141	2.153	2.164	2.175	2.186	2.198	2.208
27......	2.220	2.232	2.243	2.255	2.265	2.277	2.289	2.300	2.312	2.323
28......	2.335	2.345	2.358	2.370	2.382	2.394	2.405	2.417	2.430	2.441
29......	2.453	2.464	2.677	2.489	2.500	2.513	2.525	2.537	2.549	2.561
30......	2.574	2.586	2.598	2.610	2.623	2.635	2.647	2.660	2.672	2.685

further work was done in Mexico, Venezuela, Argentina and Peru to establish the constant. The appropriate table should be consulted for each individual case.

f. The monthly consumptive use for the crop (C.U.) is calculated and expressed in millimeters of irrigation depth, using the equation: C.U. = f.c.u. x K x 10. Place the results is column 7, and note that the months with positive consumptive use represent periods of crop development when irrigation is needed. Thus, irrigation needs vary according to the development of the crop within the vegetative period. This is why irrigation is not needed throughout the year.

g. The effective precipitation (E.P.) is calculated by applying a constant factor to the monthly precipitation values (P) obtained from Form 21 of Exercise 4. This constant is equal to 1 – Kr

TABLE No. 9.2. Table of values for insolation and solar radiance P, by degree's of Latitude South. Luque[7].

Latitude South (degrees)	Jan.	Feb.	March	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
0......	8.49	7.67	8.49	8.22	8.49	8.49	8.49	8.49	8.19	8.49	8.22	8.49
2......	8.55	7.71	8.49	8.19	8.44	8.17	8.43	8.44	8.19	8.52	8.24	8.55
4......	8.64	7.76	8.50	8.17	8.39	8.08	8.20	8.41	8.19	8.56	8.33	8.65
6......	8.71	7.81	8.50	8.12	8.30	8.00	8.19	8.37	8.18	8.59	8.38	8.74
8......	8.79	7.84	8.51	8.11	8.24	7.91	8.13	8.32	8.18	8.62	8.47	8.84
10......	8.85	7.86	8.52	8.09	8.18	8.84	8.11	8.28	8.18	8.65	8.52	8.90
12......	8.91	7.91	8.53	8.06	8.15	7.79	8.08	8.26	8.17	8.67	8.58	8.95
14......	8.97	7.97	8.54	8.03	8.07	7.70	7.08	8.19	8.16	8.69	8.65	9.01
16......	9.09	8.02	8.56	7.98	7.99	7.57	7.94	8.14	8.14	8.76	8.72	9.17
18......	9.18	8.06	8.57	7.93	7.96	7.05	7.88	8.09	8.14	8.80	8.80	9.24
20......	9.25	8.09	8.58	7.92	7.83	7.41	7.73	8.05	8.13	8.83	8.85	9.32
22......	9.36	8.12	8.58	7.89	7.74	7.30	7.75	8.03	8.13	8.86	8.90	9.38
24......	9.44	8.17	8.59	7.87	7.60	7.24	7.58	7.99	8.12	8.89	8.96	9.47
26......	9.52	8.28	8.00	7.81	7.56	7.07	7.49	7.87	8.11	8.94	9.10	9.61
28......	9.61	8.31	8.61	7.79	7.49	6.99	6.40	7.85	8.10	8.97	9.19	9.73
30......	9.69	8.33	8.63	7.75	7.43	6.94	7.30	7.80	8.09	9.00	9.24	9.80
32......	9.76	8.36	8.63	7.70	7.39	6.85	7.20	7.73	8.08	9.04	9.31	9.87
34......	9.88	8.41	8.65	7.68	7.30	6.73	7.10	7.69	8.06	9.07	9.38	9.99
36......	10.06	8.53	8.67	7.61	7.10	6.59	6.99	7.59	8.06	9.15	9.51	10.21
38......	10.14	8.61	8.68	7.59	7.03	6.46	6.87	7.51	8.05	9.19	9.60	10.34
40......	10.24	8.65	8.70	7.54	6.95	6.33	6.73	7.46	8.04	9.23	9.69	10.42
42......	10.39	8.72	8.71	7.49	6.85	6.20	6.60	7.39	8.01	9.27	9.79	10.57
44......	10.52	8.81	8.72	7.44	6.73	6.04	6.45	7.30	8.00	9.34	9.91	10.72
46......	10.68	8.88	8.73	7.39	6.61	5.87	6.30	7.21	7.98	9.41	10.03	10.90
48......	10.85	8.98	8.76	7.32	6.45	5.69	6.13	7.12	7.96	9.47	10.17	11.09
50......	11.03	9.06	8.77	7.25	6.31	5.48	5.98	7.03	7.95	9.53	10.32	11.30

where Kr represents the run-off and is equal to 0.20. Nevertheless, curves can give a better interpretation of the new process (see Figure 39). The effective precipitation is: E.P. = 0.80 x P. Usually, the precipitation is corrected above a minimum of 20 mm. per month. Data equal to or less than this minimum is recorded as found. Place the results in column 8.

h. Calculate the net depth of coverage or water replacement with the equation: D = C.U. – 0.80 P. This means that the figures in column 7 are subtracted from the figures in column 8. The difference, or net depth of coverage per field, is placed in column 9.

i. To obtain the gross depth of coverage, or irrigation requirements, at this level, the degree of efficiency of irrigation should be taken

TABLE No. 9.3. Table of values for insolation and solar radiance, by degrees Latitude North. Luque[7].

Latitude North (degrees)	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	Apr.	May	Jun.
0......	8.49	7.67	8.49	8.22	8.49	8.49	8.49	8.49	8.19	8.49	8.22	8.49
2......	8.55	7.71	8.49	8.19	8.44	8.17	8.43	8.44	8.19	8.52	8.24	8.55
4......	8.64	7.76	8.50	8.17	8.39	8.08	8.20	8.41	8.19	8.56	8.33	8.65
6......	8.71	7.81	8.50	8.12	8.30	8.00	8.19	8.37	8.18	8.59	8.38	8.74
8......	8.79	7.84	8.51	8.11	8.24	7.91	8.13	8.32	8.18	8.62	8.47	8.84
10......	8.85	7.86	8.52	8.09	8.18	7.84	8.11	8.28	8.18	8.65	8.52	8.90
12......	8.91	7.91	8.53	8.06	8.15	7.79	8.08	8.26	8.17	8.67	8.58	8.95
14......	8.97	7.97	8.54	8.03	8.07	7.70	7.08	8.19	8.16	8.69	8.65	9.01
16......	9.09	8.02	8.56	7.98	7.96	7.57	7.94	8.14	8.14	8.76	8.72	9.17
18......	9.18	8.06	8.57	7.93	7.99	7.05	7.88	8.09	8.14	8.80	8.80	9.24
20......	9.25	8.09	8.58	7.92	7.83	7.41	7.73	8.05	8.13	8.83	8.85	9.32
22......	9.36	8.12	8.58	7.89	7.74	7.30	7.75	8.13	8.13	8.86	8.90	9.38
24......	9.44	8.17	8.59	7.87	7.60	7.24	7.58	7.99	8.12	8.89	8.96	9.47
26......	9.52	8.28	8.60	7.81	7.56	7.07	7.49	7.87	8.11	8.94	9.10	9.61
28......	9.61	8.31	8.61	7.79	7.49	6.99	6.40	7.85	8.10	8.97	9.19	9.73
30......	9.69	8.33	8.63	7.75	7.43	6.94	7.30	7.80	8.09	9.00	9.24	9.80
32......	9.76	8.36	8.63	7.70	7.39	6.85	7.20	7.73	8.08	9.04	9.31	9.87
34......	9.88	8.41	8.65	7.68	7.30	6.73	7.10	7.69	8.06	9.07	9.38	9.99
36......	10.06	8.53	8.67	7.61	7.10	6.59	6.99	7.59	8.06	9.15	9.51	10.21
38......	10.14	8.61	8.68	7.59	7.03	6.46	6.87	7.51	8.05	9.19	9.60	10.34
40......	10.24	8.65	8.70	7.54	6.95	6.33	6.73	7.46	8.04	9.23	9.69	10.42
42......	10.39	8.72	8.71	7.49	6.85	6.20	6.60	7.39	8.01	9.27	9.79	10.57
44......	10.52	8.81	8.72	7.44	6.73	6.04	6.45	7.30	8.00	9.34	9.91	10.72
46......	10.68	8.88	8.73	7.39	6.61	5.87	6.30	7.21	7.98	9.41	10.03	10.90
48......	10.85	8.98	8.76	7.32	6.45	5.69	6.13	7.12	7.96	9.47	10.17	11.09
50......	11.03	9.06	8.77	7.25	6.31	5.48	5.98	7.03	7.95	9.53	10.32	11.30

into account. This is known as application or management efficiency, is represented as ApEf, and is expressed as a percentage. Depending on the irrigation system, the crop characteristics, and other factors, an average application efficiency of 50 percent to 65 percent is generally assumed for gravity irrigation systems. An application efficiency index of 60 percent or $EF = \frac{1}{0.6}$ is recommended for making arithmetic calculations.

j. Form 41 is used for calculating total consumption or gross monthly volume as a function of the different efficiencies assumed for individual fields. The data in column 9 of Form 40 are transferred to column 1 of Form 41. Since these data are expressed in millimeters, they are converted into m^3/month, and the results are placed in column 3 and multiplied by 10.

TABLE No. 9.4. Adjusting the monthly and annual crop constant K for different crops based on values of K determined in Texas (United States) and subsequently adjusted in Mexico (S.R.H.) and Argentina (U.N.S.). Luque[7].

Crops	Veg. cycle (days)	Monthly K factors: Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	Annual value of K
Alfalfa	240 to 300	–	–	0.66	0.83	0.95	1.03	1.08	1.06	1.00	0.91	0.76	0.60	0.89
Grapes	160 to 180	–	–	–	0.35	0.49	0.74	0.89	0.90	0.82	0.70	0.50	0.50	0.61
High concentration Fruit Orchards (peaches, cherries)	200 to 220	–	–	–	0.39	0.62	0.87	0.95	0.94	0.81	0.57	0.32	–	0.63
Low concentration Fruit Orchards (apples, pears)	200 to 220	–	–	–	0.36	0.51	0.82	0.92	0.89	0.81	0.62	0.36	–	0.62
Corn	140 to 160	–	–	–	–	0.49	0.66	0.82	0.91	0.92	0.85	–	–	0.77
Forage Sorghum	130 to 160	–	–	–	–	0.58	0.83	0.97	1.02	0.98	0.88	0.77	–	0.85
Peppers	150 to 170	–	–	–	–	0.41	0.41	0.50	0.79	0.82	0.70	0.53	–	0.62
Tomatoes	150 to 180	–	–	–	–	0.40	0.40	0.59	0.93	0.97	0.77	0.54	–	0.70
Potatoes	140 to 160	–	–	–	–	0.38	0.58	0.82	0.93	1.00	0.85	–	–	0.76
Small vegetables (Intensive)	60 to 130	–	–	–	–	0.62	0.81	0.95	1.02	1.00	0.93	0.84	–	0.88
Peas	150	–	–	–	–	0.48	0.80	0.93	1.04	0.94	0.77	–	–	0.82
Irr. pasture	280	–	–	0.58	0.71	0.82	0.89	0.91	0.92	0.90	0.86	0.78	0.67	0.80
Cotton	140 to 180	–	–	–	–	0.34	0.46	0.62	0.99	0.95	0.74	0.70	–	0.71
Tobacco	140 to 160	–	–	–	–	0.41	0.41	0.64	0.89	1.06	1.04	–	–	0.81
Olives	180 to 240	–	–	–	–	0.18	0.32	0.58	0.76	0.80	0.72	0.52	0.34	0.52
Walnuts	160 to 220	–	–	0.18	0.25	0.44	0.64	0.80	0.86	0.78	0.60	0.40	0.25	0.52
300 day crops (Grass, grapes)	300	–	–	0.32	0.55	0.74	0.87	0.96	1.00	0.98	0.93	0.72	0.66	0.78

The constants are listed by annual period for the average vegetative cycle (central and south-central part of the country), according to the zone; the group of K factors selected can occur earlier or later for the corresponding crop months.

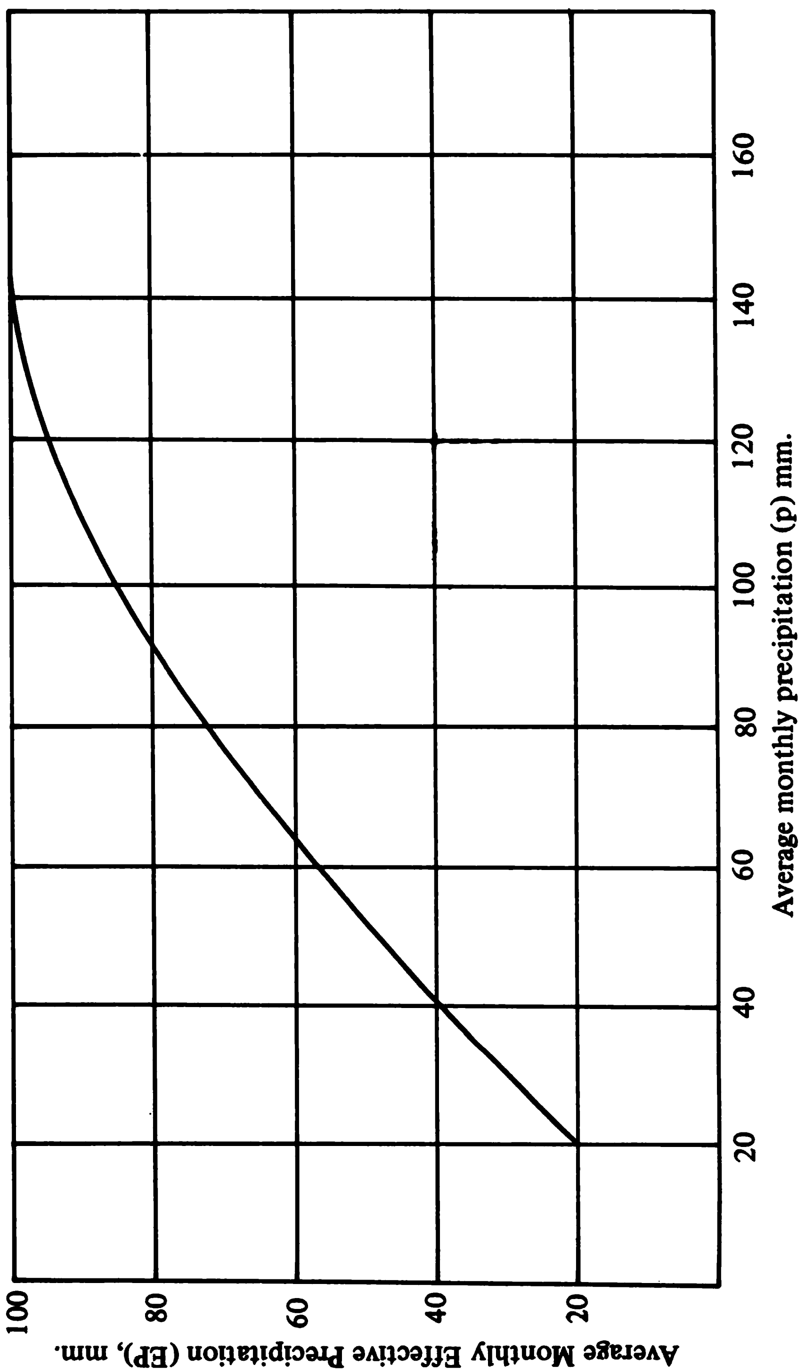

Fig. 39. Effective precipitation according to Blaney and Criddle, 1962. Source: Luque[7].

Form No. 41. Gross monthly requirement or volume at the field level, as a function of different efficiencies.

Crop: ______________________________

MONTHS	Net requirements at field level		Gross consumption or volume according to efficiency of irrigation systems (m^3)		
	Net depth of coverage or replacement C.U.–0.80 P (mm)	m^3/month	By gravity $E_f = 0.60$	By gravity for $E_f =$ ____	Mechanized and highly efficient $E_f =$ ____
	1	2	3	4	5
July					
August					
September					
October					
November					
December					
January					
February					
March					
April					
May					
June					
ANNUAL					

k. These data are used to calculate total consumption on the field level for each month, and the value for the period under consideration is found by adding the monthly values.

$$\text{Consumption at field level} = \frac{\text{net depth of coverage}}{\text{efficiency}} = \frac{\text{Column 2}}{\text{column 4 or 5 or 6 depending on efficiency assumed}}$$

This calculation shows lower monthly values at the extremes of the period or during months of high precipitation.

Experience has shown that for common surface irrigation (non-mechanized) with depths of coverage less than 600 m^3/hectare (60 mm. deep) the use of irrigation via dikes and ridges is not viable. Consequently, this value is used as a minimum acceptable for this method. The minimum value for furrow irrigation systems is defined as 400 m^3/hectare (40 mm. deep). These minimum limits do not apply for other irrigation systems, such as sprinkler and drip irrigation.

l. The next step is to calculate total monthly irrigation requirements for all crops on the agricultural firm. Form 42 is used for this purpose and should be drawn up for all months in which irrigation is required. Data on consumption per hectare of each crop, obtained from column 3, 4 or 5 of Form 41 according to the efficiency assumed, is placed in column 1 of Form 42. The number of hectares of each crop in the firm is placed in column 2. Total consumption for each crop appears in column 3 and is found by multiplying column 1 by column 2. Column 4 shows the efficiency of distribution, which is generally assumed to be 80 percent. The gross depth of coverage at the intake level by crop and for the farm is determined by multiplying the data of column 3 by the efficiency for each crop (column 4).

m. Calculate the variable costs and the value of investments in irrigation equipment.

For the benchmark plan

1) The data for the farm's particular irrigation system can be found in Form 13.

2) These data are used for preparing a summary, which is compared with the prices paid for water use, as indicated in the consumption figures calculated in 1). Include any other variable costs which have been omitted. Total variable costs are the sum of the variable costs which appear in Form 13 plus any others which may have been calculated elsewhere.

3) For alternative plans, the same procedure should be followed, using the crops as variables. It will, of course, be necessary to recalculate the consumptive use.

future plans can seldom be enacted uniformly over a given period. Thus, for example, potato fertilization plans can be changed from year to year without greatly affecting the other aspects of the farm organization. Therefore, while price expectations for the following year may be appropriate for analyzing the problem, the optimum results of more complex changes are generally not felt until the end of a transition period lasting at least two years or more. Thus, more complex changes should often be analyzed through long-term price relationships reflecting the general outlook for at least five or ten years to come.

The forecast of future price relationships implies certain risks; however, decisions must constantly be made on the basis of certain implicit assumptions about future prices. The farmer would do well to obtain the best information possible before making any decision. At the same time, economists should receive more training so as to make more accurate forecasts than the farmers.

The ultimate success of an agricultural enterprise depends in large part on the farmers' ability to adapt the factors under their control to the current price structure produced by market forces and administrative policies.

OBJECTIVES

a. To prepare an evaluation of the benchmark plan and alternative plans with data collected from interviews and other sources available to the planner.

b. To determine the future plan of action for the farm.

PROCEDURE

a. Calculate net income for the alternative plans and select those which were given high priority in Form 36. Consider the desires and objectives of the producer. Use Form 43 for this purpose.

b. Prepare a summary of investments needed.

c. Prepare a summary of the loan and repayment plan for the farm. Use Form 44.

d. Prepare a written evaluation of the various alternative plans. Remember the objections and potential of the farmer and the family, and base comparisons on "normal" year figures.

Form No. 43. Financial summary of the benchmark plan and alternative plans.

CROP AND/OR LIVESTOCK PRODUCTS	Benchmark Plan	Alternative Plans	
		Plan I	Plan II
	Gross Income		
1.			
2.			
3.			
4.			
5.			
6.			
TOTAL			
	Total expenses		
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			
15.			
TOTAL			
Gross income less total expenses	Net income		

Form No. 44. Loan and repayment plan.

ITEM	YEARS								
	1	2	3	4	5	6	7	...	...
Investments in installations									
Accumulated balance									
Interest at ____ % on accumulated balance									
Interest at ____ % on additional investments (1)									
Accumulated balance plus interest (2)									
Increase in liquid cash income (3)									
Remaining balance (4)									

(1) Interest on additional liquid investments (equipment and livestock purchases).

(2) Sum of the three previous items.

(3) Excess of liquid income under Plan I over liquid income under Benchmark Plan.

(4) Difference between the two previous items.

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For all these professionals, this text gives a succint orderly analysis of the principles and methods of planning, research and analysis of agricultural enterprises.

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