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There seems to be a lack of information and even much misinformation as to how agricultural experiment stations should be planned, organized, and operated. The problem becomes more serious in some of the developing countries that have organized their stations based on technical knowledge and management practices from more advanced countries whose agricultural, political, and social conditions may be very different.

The purpose of this study was to fill what is believed to be a serious gap in experiment station management, that is, to provide management principles and guidelines.

This study was accomplished by evaluation of ideas and opinions obtained from personal interviews with farm superintendents in the United States and with directors and research staff of experiment stations in Colombia and Ecuador.

This study includes a review of the origin and development of the agricultural experiment stations and gives primary emphasis to the principles of planning, organizing and staffing an experiment station.

The functions performed in an experiment station and their interrelationship to the efficient use of the resources available were especially considered. The selection and qualifications of a director of an experiment station was stressed.

The factors that need be considered in the location of the station and the location and construction of the various facilities were also discussed. The importance of effective management of the land and efficient operation of the services and facilities were also discussed.

This study concludes stressing the need for formal training programs for the personnel responsible for the operation and management of experiment stations, and recommends that evaluation of the management, policy matters, and of the services and facilities be conducted periodically in order to detect and correct when problems and/or conflicts arise.

Some Principles and Guidelines for the Establishment of an Agricultural Experiment Station

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SOME PRINCIPLES AND GUIDELINES FOR THE ESTABLISHMENT OF AN AGRICULTURAL EXPERIMENT STATION

INTRODUCTION

The progress made in agriculture in the last 150 years has contributed more to the welfare of many nations than perhaps any other activity.

Much of the improvements and discoveries originated in the agricultural experiment stations were financed and developed by private organizations or by public institutions.

Investments in agricultural research have been found to yield good returns to society. Economists such as Heady (10), attempting to evaluate agricultural research returns, have concluded that:

> Society would have difficulty in finding many investment opportunities, in either the public or the private sector, which had greater promise of return to consumers in general than this activity which has been embraced as an active public policy.

All available evidence indicates a high rate of return on research expenditures. However, it is extremely difficult to evaluate the return to research investment empirically.

Some worthwhile research cannot be valued in monetary terms. The improvement in human health resulting from the production of vegetables with desirable vitamin content is an example of an important non-monetary return to research (19).

As early as 1934, Secretary of Agriculture Henry A. Wallace (33) stated that: "A dollar of investment by the government for scientific research in agriculture brought back a hundred dollars."

Zui Griliches (7) estimated the realized returns for public and private investments in hybrid corn research. He concluded, as of 1955, the return to be 700 percent for each dollar expended in hybrid corn research. Griliches concluded that the return to public and private expenditures on agricultural research ranged from 35 to 170 percent.

It is difficult to establish precisely the rate of return from agricultural research. However, there is agreement that the return has been extremely high.

As new discoveries have been made the methods and quality of research have become more and more sophisticated and efficient.

The emphasis and support given to the experiment stations is increasing in many countries especially in the developing nations that have been predominantly an agricultural economy.

It is evident that in many situations the emphasis put in the need for research has resulted in the creation of experiment stations without the necessary planning in regard to the form of organization to be used, the type of management, the personnel trained in administration and without even a master plan of the facilities needed at the moment or at a later date.

In contrast the research projects are usually planned in advance and the objectives and methods used are discussed in depth. But research cannot be conducted, efficiently at least, without a minimum of services and facilities and the various administrative rules and procedures that are necessary for an organization to accomplish its objectives.

Where the situation exists in which there is not the proper balance between research and administration and services there results a waste of human effort and inefficient use of funds and time. This in turn creates and atmosphere of frustration for the investigators whose work will be affected in quality and quantity.

There seems to be a great lack of information, even misinformation, as to how agricultural experiment stations should be planned and managed. What makes it even more difficult is that there is nowhere available, to the author's knowledge, any comprehensive study of the many important and essential factors that need be considered in the organization and management of an experiment station.

The research man, that for one reason or another finds himself in an administrative position faces a very difficult situation because he cannot find a source of information to guide him and because in the majority of cases he has received no training in administration, personnel management or human relations.

In the same situation is the individual or group of individuals

who are given the responsibility either by a private or public institution, to plan and organize agricultural experiment stations.

These problems and the fact that more experiment stations are going to be started in various countries around the world plus the improvement that is necessary in some of the already established stations suggested to the author that a study was needed in which the opinions and practical experience of people working in this area of experiment station management are brought together along with principles of organization, personnel management, human relations, etc. so as to constitute a comprehensive source of reference that would be of help to people involved in planning, organizing and operating an experiment station.

It must be clearly stated that it is not the purpose of this study to deal with the forms of organization or policies of national research institutes as found in many countries or the system of state experiment stations as found in the United States, but rather this study will be concerned with the "experiment farms" that are a part of larger research institutions.

The words "experiment station" or "station" as used here and elsewhere in this paper refer to an agricultural experiment station or experiment farm unless otherwise indicated.

An agriculture experiment station may be defined as a field laboratory which seeks to discover and evolve solutions to

technological problems of the farmers and of related industry through research on plants and animals.

ORIGIN AND DEVELOPMENT OF AGRICULTURAL EXPERIMENT STATIONS

There seems to be agreement among authorities on the subject that the first experiment stations were started about the middle of the nineteenth century, and that before that time there was practically no agricultural research as it is known today.

Various stations were started simultaneously in Europe and were financed with private funds from farmers' associations which also contributed land, labor, buildings and cattle (12).

In Europe the first agricultural experiment station was the one founded by J. B. Boussingault at Bechelbronn in Alsace, France in 1834. Boussingault carried field experiments in his own farm and established a chemical laboratory in which soils and crop products were analyzed. "He was the first to prove by means of field experiments and chemical analysis that legumes are able to obtain nitrogen from sources not available to plants (34).

In England in 1834 was founded the Rothamsted Agricultural Experiment Station near London by Sir John Bennet Laws on a farm he had inherited. This station is considered the oldest in the world today. According to Salmon (25) at no other station have experiments been conducted continuously on the same field and in substantially the same manner for so many years.

In Germany in 1852, a group of Saxon farmers opened the first farmer's station for agricultural experiments at the village of Moeckern, near the city of Leipzig. It was so successful that two years later another group of Saxon farmers set up a second station in the town of Cheminitz.

> The experiment stations shortly came to be regarded not as a costly embillishment or an agricultural luxury, in which university or wealthy gentlemen might harmlessly indulge, but as a most remunerative and most necessary agency for the use as well as for the education of farmers (12).

Twenty-five years later there were 19 experiment stations in Germany, 16 in Austria and ten in Italy.

The improvements in agriculture taking place in Europe gradually became known in the United States. Many scientific societies were founded such as the American Academy of Arts and Sciences founded in 1780 and which encouraged the investigation of European ideas and experiences and agricultural experimentation. The South Carolina Society for Promoting and Improving Agriculture, was organized in 1785. In one of its rules it recommended to the planter in general "to select a small part of his grounds, in order to make experiments on it by various methods" (30). The first society to publish the result of its work was the Philadelphia Society for Promoting Agriculture.

In 1852 the number of agricultural societies had increased to

300 and by 1860 they numbered over a thousand, and were a chief means by which improvements were brought to the farmers.

As the number of the agricultural societies increased it became more evident the need for institutions where agriculture and sciences related to it could be taught. Early in the 1800's many agricultural leaders saw the need for this type of education and had pointed out its desirability. By 1852 a number of private colleges were giving instruction in agriculture, but since their efforts were limited a number of leaders were urging that the federal government assist in making agricultural education available to all citizens.

As a result of this campaign and the rising public opinion for the creation of agricultural colleges Congress passed a bill known as the Land-Grant College Act which became law with President Lincoln's approval on July 2, 1862. This law provided each state with public land and authorization to sell and to use the proceeds to endow their respective agricultural college (32).

The establishment of the state colleges of agriculture marked a very important step in the advancement of American agriculture. But many questions of agriculture could not be answered without more thorough scientific knowledge, therefore, some of the states found a way to do some research at the agricultural college (30).

In 1875 the Connecticut Experiment Station was established at Wesleyan University, Middletown, Connecticut. It was the first state

supported agricultural experiment station in the United States. During the next decade a number of other states established stations.

The campaign for a nation-wide system of experiment stations culminated with the Hatch Act in 1887 which created the experiment stations

> . . . in order to aid in acquiring and diffusing among the people of the United States useful and practical information on subjects connected with agriculture and to promote scientific investigation and experiments regarding the principles and application of agricultural science (14).

This law provided for a yearly grant to each state for the support of an agricultural experiment station. A very significant provision of the Hatch Act stated that these stations should be located at the agricultural colleges established by the Land-Grant act of 1862. The role of the experiment stations in relation to the colleges was intended to be as a fact finding agency to provide information to the resident teaching and extension for the benefit of students, farmers and the public in general.

Origin of Experiment Stations in Latin America

There are no exact accounts as to when or where research or experiment stations start in this part of the American continent. Records available indicate the first attempts to conduct research in demonstration farms probably took place at the time when the United States began sending missions of technical assistance to the Latin

republics in the early part of 1940. In 1943 under the auspices of the Good Neighbor Policy the Inter-American Institute of Agricultural Science was established. Its purpose was "to encourage and advance the development of agricultural science in Latin America, through research, teaching and extension activities" (14).

Due to the efforts of these missions many experiment stations were established and were patterned after Beltsville and consequently their direction was given to the Ministries of Agriculture of the countries involved. However, after a few years it became evident that this was not the best arrangement because the traditional bureaucracy and red tape of the ministries made it difficult for the experiment stations to operate efficiently.

As a consequence new agencies were created and given the responsibility of conducting research. Even though the names given to this organization vary from country to country basically their organization and objectives are similar. These national institutes for agricultural research, as they are called in some countries, are autonomous and depend upon the Ministries of Agriculture only for budgetary purposes.

The attempts to establish these national institutes for agricultural research using as a model the state experiment station system of the United States have not been entirely successful because these institutes do not have an organization structure in which research,

education and extension are integrated. Instead, while research is the responsibility of the institutes, education ties to the Ministry of Education and extension is handled by a variety of organizations.

Fortunately many countries have recognized the insignificance of a precise form of organization and are performing effectively under a variety of patterns of governing bodies. It is recognized, however, that education and extension must be integrated with research but taking in consideration that the political and social structure of each country make it necessary that any system must be adapted rather than adopted.

PLANNING AN EXPERIMENT STATION

The success of any activity be it a business enterprise or a camping trip depend on the degree of planning performed before the activity is to start. An experiment station is no exception, a great deal of planning must take place if it is expected to have valid programs of research and if it is to make efficient use of the taxpayer's money.

The importance of good planning cannot be overemphasized because a great number of experiment stations fail due to a lack of competent planning. Obviously there may be other reasons why some stations fail to reach their objectives but in the majority of cases the problem can be traced back to poor planning during the initial stages.

On the other hand faulty planning may also be attributed to inadequate competency of the planners. To plan an agricultural experiment station is not enough to be a highly trained scientist because there are other factors to be considered besides the research aspect. Factors like administrative procedures, the financing and the social and political implications must also be given prime consideration. Since it is difficult to find individuals with such a background a planning committee should be formed with individuals of experience in research, engineering and administration.

In an experiment station's planning and development program it

must be considered that only men with both research and management breadth are capable of assigning proper significance to many different considerations in chartering a future course of action.

The committee should have access to all the information they need to make an intelligent and as complete as possible master plan. Such a plan must systematically account for the activities of all the major functions of the experiment station for a prescribed period of future years.

The activities of the experiment station are guided by the overall objectives, therefore, the starting point of planning is the establishment and definition of the objectives.

Establishing Objectives

The importance of this is inferred from the definitions of planning which state that planning is the process of setting the objectives to be accomplished by an organization (or segment of it) over different periods of time and deciding on the major methods of reaching them (15). It is also referred to as the working out in broad outline the things that need to be done and the methods for doing them to accomplish the purpose set for the organization.

From this point of view then, planning must be for or toward some goal to be meaningful, because the objective gives the key as to what basically to do, where to place the primary emphasis and what

to accomplish.

Regardless of the nature of objectives, they must be understood if plans of any meaning are to be pursued. Thus the objective of the entire research program should control the direction of major plans affecting the experiment station as a whole. These plans in their reflection of this objective will help define the objectives of smaller research programs or departments and so on down the line through the organization structure. Moreover the smaller subdivisions will do their planning more effectively if they understand the overall objectives of the research program.

This is important to keep in mind because an experiment station regardless of its size has in its organization structure departments or sections that perform other functions that constitute support for research such as administration, services and facilities. For these to be efficient they must be planned with the overall objective of the research program in mind.

The specific objectives of an experiment station vary according to the particular circumstances, however, overall objectives may be applicable to most agricultural research organizations. The means to reach these however are quite different in most cases.

According to Allen, Beal and Steece (2) the objective of an experiment station should be to carry on organized research for the advancement of agricultural knowledge. Jardines (12) states that

the objectives are:

1. Make discoveries for improvements of agriculture.
2. Secure facts which will answer questions and solve problems confronting agriculture now or in the future.
3. Gather facts to make teaching and agricultural practices more effective.
4. As publicly supported institutions the agricultural experiment stations are obligated to develop agricultural technology which in turn will contribute to the welfare of all classes of people and of the nations.

True (30) considers that agricultural experiment stations should:

1. Act as bureaus of information on many questions of interest to the farmers in their localities.
2. Seek new methods of agriculture, the introduction of new crops and livestock and the establishment of new industries.
3. Aid the farmer in his fight against pests that plague his crop and livestock.
4. Investigate the interaction of air, water, soils, plants and animals to find out the principles which can be applied in order to make optimum use of available resources.

The International Center of Tropical Agriculture at Cali, Colombia has designed its general activities to:

1. Develop and demonstrate production systems for specific crops and animals in specific environments.
2. Develop information and practices for use in bringing into economical production specific lowland areas not presently developed or fully utilized.
3. Develop and demonstrate effective techniques and strategies for the rapid spread and adoption of improved varieties and agricultural practices.
4. Provide an information center to process and exchange data and references relevant to the agricultural and economic development of the lowland tropics.

But spelling out aims in this way is of value only if every station activity is in harmony with the rest and directed toward the over-all target; consequently, specific objectives must be developed for each research program and service activity.

Defining the objectives clearly and concisely will help to put the plans into action more effectively and later on to make a more accurate evaluation of the things accomplished.

Determining and Evaluating the Resources Needed

Establishing the general and specific objectives leads to the next important step in planning: That of defining and identifying the resources that would be needed to put the plans in action.

Therefore when an experiment station is being projected it is necessary to calculate what it is going to take in terms of capital development and operating funds to operate the station. Factors that must be considered are the cost of the land, buildings, facilities, equipment, electricity, water supply, roads, fences, labor, irrigation and drainage systems, etc.

As was mentioned before a planning committee should be involved during the planning stage. This committee might be divided in two groups--one to be in charge of planning the research activities of the station and the other to be in charge of planning the station's operations. However, both groups must work together and in coordination.

The station's operations are all the activities related to the administration, the services and the facilities and their personnel that are indispensable for effective research.

The amount and type of research to be conducted will determine the planning of station's operation activities.

On the basis of types of research the research stations can be classified as to:

1. Multi-purpose stations: Where research covers a broad field of inquiry, including field crops, orchard and vegetable crops, livestock production and agriculture economics, etc.

2. Single or limited purpose stations: That deal with a single crop, a small group of crops or a very limited objective. For example soil erosion, rice, citrus crops, or swine production.

Facilities and Services

The type of experiment station and research to be conducted will determine the type and number of services and facilities that will be needed. The following is a list of services and facilities that should be considered in the planning process:

Facilities:

a. land

b. roads--main, secondary

c. fences

d. irrigation and drainage

e. electric power

f. domestic water systems and sewage disposal systems

g. buildings for--

   1. offices, laboratories, library, conference room, cafeterias

   2. warehouse and storage

   3. machine shop

   4. greenhouse and head house

5. drying sheds

6. processing of crops

7. barns

8. corrals

h. tractors and implements

i. laboratory and field equipment

Services:

a. experiment farm operations

b. farm production and propagation

c. shop operations

d. buildings and grounds operation

e. stores operations

f. administrative operations

More will be said about services and facilities in the chapter dealing with organization. These have been mentioned at this time to stress the fact that when calculating the capital development needed, it is necessary to consider a number of items that tend to be ignored or are given little attention even though they may determine the success or failure of a research project.

Also it must be realized that the research programs and the station's operations will work effectively only and if they are properly staffed and therefore salaries and other expenses must also be considered.

The planning committee would be wise if it keeps in mind that often times, whether it is in a Latin American or North American institution, the kinds of funds available are less than what is needed. Therefore it is necessary to have already calculated the minimum level of funds with which the station could be established for continuous operation.

If adequate funds up to that minimum level cannot be obtained then it would be better to put the plans away until a future time when funds may be available. To do otherwise would be to defeat the objectives that were established.

On the other hand if it is considered that the research program to be carried in the station is valid and worthwile, one that will produce results and produce an impact, then, a decision must be made in regard to what would be the desirable dimensions of the program to be able to make the most use of the funds available.

Under these circumstances two things may happen: 1) if the program is successful it may be used as a negotiating power to obtain more funds and implemented as originally planned; 2) if the program fails the chances for identifying additional support are nil. This is a decision that has to be made. There is no point in starting agricultural experiment stations unless they can be adequately financed, thus giving their scientists good equipment, adequate budgets and attractive salaries.

Besides the capital development and operating funds the planning committee must also consider the availability of trained personnel especially for the time when the plans are to be put into action.

Planners tend too easily to assume that enough research and management talent will be available no matter how ambitious the plans may be. The "lead" time needed for development of the management of the station may be longer than that needed for any other single factor in order to reach the objectives.

It is well to remember that personnel trained in administration and operation of experiment stations are very scarce, therefore manpower planning should figure prominently in the conception of a master plan because the best of plans still need people to translate them into actions.

This, then is the preparatory phase of master planning for the future. First, setting forth our objectives in such terms that we know clearly what we want to accomplish; and, second, identifying the resources available to put the plan in operation.

ORGANIZING

An agricultural experiment station to be successfully operated and managed must have an effective organization. It is very important to be familiar with at least the basic principles of organizing and to apply them with the objectives of the station in mind.

The starting point in organizing for effective administration is the objectives of the station. These, as we have seen, define the purpose for which the experiment station is established. Every action must be consistent with the objectives which, in the area of organizing, suggest the functions which are basic to the experiment station's success.

Organizing as defined by Koontz and O'Donnell (15) is

> the grouping of activities necessary to attain enterprise objectives and the assignment of each grouping to an executive with authority necessary to manage these activities, and involves establishment of authority relationships with provision for coordination between them, both vertically and horizontally in the enterprise structure.

Dale (5) states that "Organization" as the term is used in management is a method of insuring that:

1. The work necessary to achieve the goal is broken down into segments, each of which can be handled by one person.
2. There is no duplication of work.

3. All efforts are bent toward a common goal.

Thus, organizing implies that the work must be divided so that most jobs can be done by people with specialized skills and/or knowledge, and that means must be provided for the coordinating of the jobs done by different people. In other words, the aim of organizing is to enable a group of people to function as a unit doing his job without hampering the efforts of the others.

Basically all human organizations have three essential common features. First, they have an objective. Second, there are people, the implements by which the organization gets its work done and produces the results which are the reason for its existence. Third, there is a structure, the way the people are placed in working relationship with each other.

The people and the structure must be well tuned to its objectives for the organization to be most effective. Therefore, when the organization structure is being developed it is important to consider several principles or generalizations.

Principles of Organization

1. The principle of specialization: Similar activities should be grouped in the same organizational unit, and the directions of these similar activities should emanate from that organizational unit, even though parts of the activities

are carried out elsewhere.

In order to achieve economies in operation, it is necesary to conserve resources. One way to conserve human resources is to centralize the direction of activities requiring specialized knowledge and experience. As an example, all research activities related to wheat, oats and barley should be centered in one unit--a small cereals program.

2. The principle of unity of command: Each employee should be accountable to only one superior. The members of the organization are arranged in a determinate subordinate-superordinate hierarchy line of positions, sometimes referred to as the "scalar process," wherein lines of positional authority and responsibility run upward and downward through several levels with broad base at the bottom, and a single head at the top in order to preserve the "unity of command."

This principle is a most important one. Man cannot serve two masters. He must be told clearly to whom he reports and looks for direction. He cannot work well in a situation in which the authority to command his labor is divided among two or more superiors. Conflicting orders are certain to result, with lowered morale on the part of the employee as well as lowered production due to the lowered morale and general uncertainty.

Pfiffner and Presthus (21) say that: "In an effective organization each worker knows who his superior is, and each superior knows whom he is expected to supervise." They state that every member of the organization should report to one and only one leader. Gulick (9) in discussing this principle said: "A workman, subject to orders from several supervisors, will be confused, inefficient, and irresponsible."

3. The principle of delegation of authority and responsibility: Decisions should be made at the lowest competent level; that is, authority and responsibility should be delegated as far down in the organization as possible.

Simon (27) indicates that: "One of the most important uses to which authority is put in organization is to bring about specialization in the work of making decisions, so that each decision is made at the point in the organization where it can be made most expertly."

To obtain the maximum benefit from good organizing, it is necessary to delegate as far down in the organization structure as possible the power to carry on the various activities essential to the success of the enterprise.

Delegation of authority must be real. Steiger (28) states that delegation of authority "includes not only what a superior says to his subordinate, but also the way in which he acts. An important ingredient in delegation is the willingness to permit the subordinate to make

a reasonable number of mistakes."

4. The principle of span of control: The number of subordinate positions directly accountable to a manager should be that number which best balances the essential subordinate activities; the abilities of the superior, and the communications and expense aspects of the situation.

In general, theory supports the belief that no top administrator should supervise more than five or six division chiefs or immediate subordinates. The number of persons or units which an individual can supervise is determined largely by his ability to maintain communications with them.

According to Graicunas (8) the superior in dealing with his subordinates, must keep in mind not only the direct relationships between himself and each subordinate as an individual but also his relationship with different groupings of the subordinates and the cross relationships between all subordinates. These relationships vary considerably with the size of the subordinate group. While the superior's own direct relationships with individuals increase in proportion to the addition of subordinates, the group and the cross relationships increase much more proportionately.

5. The principle of clear statement of authority and responsibility: Each position should have a clear statement of its responsibilities and the authority of the incumbent to

discharge these responsibilities.

Authority should be equal to responsibility; that is when anyone is given responsibility for a task, he should be given enough authority to accomplish it successfully. There are a number of ways to set out the responsibilities of a position. One of the most common is to use job descriptions which set forth the activities required in the position, the reporting relationships and the interrelationships of this position with others in the firm with which coordination is essential. Job descriptions are dealt with at greater depth in section dealing with staffing.

Functions Performed in an Agricultural Experiment Station

As was mentioned earlier the actions in an organization must be consistent with the objectives, in organizing an experiment station this refers to the functions which are performed in it.

In an experiment station it is obvious that the most important function is research. But research alone cannot operate effectively if at all. Two other functions are indispensable: administration, and services. How these three functions are organized and how they operate is the key to an effective experiment station.

Research

The specific research projects carried out in an experiment

station will vary according to the specific objectives of the experiment station. How the many research projects are organized are beyond the scope of this study. The main concern is with the organization of the other two functions--administration and services.

However, from what was said in the principles of organizing it should be clear that research projects should be organized in programs or departments according to the principle of specialization. The principles of delegation of authority, span of management, etc., should be applied accordingly. Research organization should be so planned that the objectives of each program or department can be attained with the lowest possible cost, which may mean either money costs or human costs or both.

According to Mosher (18) the organization of the research of an experiment station needs two special qualities in addition to the normal requirements of good organization. First, research specialists of different technical fields should be able and encouraged to cooperate on individual projects. Second, it should assure that each new technique being developed or tested is assessed from the standpoint of its effect on the whole farm business.

In addition to having scientists of different specialties it is important to have a number of individual projects set up in such a way that the various specialists have to work together. Some experiment stations already do this effectively, but still there are

experiment stations where a department does not know what the department next door is working on.

A good idea is for the whole staff of the station to participate in selecting projects of high priority to their region. Then, each project is organized so that all of the relevant specialists have a role in carrying it through together.

Administration

The only reason administration exists in an experiment station is to provide service to research. Administration may be defined as the guidance, leadership and control of the efforts of a group of individuals toward some common goal. In the situation of an experiment station the common goal is to provide the most efficient and timely service to the various research projects, and this is done by providing a set of administrative procedures, rules and regulations that foster coordination and communications; and should be flexible enough so that they can be modified or changed when necessary.

Rules and regulations imply on the one hand that someone is enforcing them and on the other hand that others must abide by them for their benefit.

Services or Experiment Station Operations

The various other services needed in an experiment station can be considered under the heading of Experiment Station Operations. Their mission must be to cooperate with the research units of the station and to provide them with adequate facilities and efficient service. When these are inadequate they influence both the quality and quantity of the work as well as the morale of the researcher. Very often poor services and facilities have been a deterrent to the development of otherwise well organized research programs.

The proper organization of the experiment station operations of many stations is something that is often neglected or considered of secondary importance. Very seldom one finds a station where the services have been planned. There is but a faint concept of the objectives or role of the station operations. Some stations have been carrying out research for three or more years before some of the very basic services were provided. In others, some of the facilities have been built according to the personal desires of the individual doing the planning and without consulting the people who after all were going to be making use of it. A lack of a master plan with projections for the future is another reason why various facilities in the station are put up like topsy. Another reason for the poor organization of this function of the station is the unfamiliarity of the very basic principles

of organizing. The author found situations in some experiment stations in Latin America where some key personnel were not quite sure who their immediate supervisor was and others who were receiving orders from two people at the same time.

One way to solve some of the problems mentioned is to build an organization structure that is flexible enough to allow the necessary changes when needed and to conduct periodic evaluations of the effectiveness of the structure created.

The following is a list of brief descriptions of the various services. Again it should be remembered that the necessity of all or only a few of these in an experiment station depend on the type of station whether it is single or multi-purpose and whether the research is of the intensive or extensive type of research.

1. Experimental Farm Operations

   Field services to research programs

   Operation and maintenance of the experiment station

   Supervision and training of field labor

2. Farm production and propagation

   Production and processing of seed and propagation of vegetative material

3. Shop operations

   Maintenance and repair of vehicles, machinery and equipment

Construction and remodeling of machinery and equipment

4. Buildings and grounds

Maintenance, repair and consturcution of all buildings and facilities

Maintenance of grounds around all buildings and facilities

5. Store operations

Procurement of materials, supplies, machinery and equipment

Storage and distribution of materials, supplies, machinery and equipment

Control of all inventory property.

Management Systems

Before an organization structure is established a discussion of the possible management system will help to orient what would be the position of research, administration and station operations in the structure.

There are many management systems, perhaps as many as there are experiment stations. In general, two factors seem to determine the difference among them--one is the size of the station, the other is the organizational structure and the position that the superintendent, or director, has in the organization. This last factor is very important because it determines the amount of authority

that will be delegated to him in order to perform his duties.

It should be pointed out that the titles superintendent and director have different connotations in various countries. In the United States the director of the experiment station is that person who holds the top executive position in the State system of experiment stations. And superintendent refers to the person who manages an individual experiment farm. In many other countries the director of the experiment station has the responsibilities that the superintendent has in the U. S., and holds top position and maximum authority in the hierarchy of the experiment station.

For purposes of this study the word director will be used instead of superintendent, with the understanding that the director holds the top executive position in an experiment station.

The three most common systems of management found at stations visited were as follows:

1. A research committee is in charge of the administration, and operations of the experiment station and a subprofessional man is in charge of the field work.

2. A research staff member acts as director (superintendent) on a part-time basis.

3. A research staff member is the director on a full-time basis and who may or may not do some research.

Evaluating each one of these types of management it is found

that the first two offer definite disadvantages that make them undesirable. Considering the system where a research committee is responsible for the administration and operation of the station the first thing that comes to mind is that in a station there are many problems that arise every day, some are complicated and need to be resolved as soon as they become evident; others are small and require rapid handling. In such situations management by committee is very inefficient. First, because it involves several individuals at a time; and second, it cannot reach decisions rapidly.

The second system where a staff member acts as director on a part-time basis is also inefficient because it is difficult to do two jobs at the same time and do them well. The author is aware of cases where part-time directors have tried to schedule their activities so that they would take care of administrative business in the mornings and do research in the afternoon, or vice versa. In most cases the results have been less than satisfactory and usually frustrations have developed. This of course goes in detriment of the activities of the research station.

The third system where a staff member is the director on a full-time basis is the more desirable and efficient. Some full-time directors would like to be able to do some research, however, it is doubtful that in the larger experiment stations this would be possible. In fact in the larger experiment stations in Ecuador, for instance,

where the director must review and approve all of the research projects, besides being responsible for the administration and operation of the station, it is evident that he does not have time to supervise directly the various activities of the station's operation.

As a result there is a trend toward a different form of organization. In most cases the problems revolve around the duties and responsibilities of the director. Some stations have grown to such a degree that the best possible solution might be to have two directors of the same professional level with different duties and responsibilities but of course with a high degree of coordination. One director would be in charge of the research function only. His responsibilities limited to reviewing and discussing the research projects and developing coordination and communication among the research programs. His authority limited to granting his approval or disapproval of projected experiments.

The other director would be called administrative director and would be responsible for administrative and operation of the experiment station. From an administrative point of view, all the personnel of the station research and administration would be under him.

It is obvious that in a setup like this coordination and communications would be of prime importance.

In smaller experiment stations one director should be able to

handle several functions, assuming of course that he has the qualifications needed. Besides the technical training he needs proper training in administration, human relations, engineering, etc. More will be said about this in the section under staffing.

There are some experiment stations in Latin America where there is an administrator who is responsible for the experiment station's operations and who holds the immediate position under the director in the organization hierarchy. A more appropritate title for this position would be "chief of operations" because the administrative functions are actually performed by the director.

The position of the administrator is a very awkward one mainly because even though he usually has a strong agricultural background he does not hold a university degree, and yet because of his position he may receive a salary that is equal or higher than some of the research staff members'. Even though he holds the second most important position in the hierarchy his authority is not commensurate with his position and responsibilities. Under these circumstances he cannot effectively organize and operate the services of the station.

The fact that the administrator holds the line position immediately under the director implies authority over research staff members of higher professional level who do not feel happy about the situation and often take their problems directly to the director.

Under these circumstances it is difficult for all concerned in

the station to work effectively. The situation could be improved by making the administrator's position a staff instead of a line position. A further improvement would be to require that the administrator be a university graduate with the proper training and background.

To sum up, a system of management rated as very efficient in one station may be quite inadequate and detrimental when used in another. When evaluating a system of management in an experiment station the important thing is to find out whether it is providing a healthy atmosphere among the personnel, effective administration, adequate facilities and efficient service.

Figure 1 shows the relationship that must exist between research and services and among the services. As can be seen no one unit can function all by itself, it needs the support of one or more other units. Inefficiency in one unit will automatically show up or have its effect in other units.

The fact that the services only objective is to serve research does not mean, however, that the latter should place undue demands on the former. A research program staff member should not go to the superintendent or director and request a field to be plowed the very same day because the director very probably has already scheduled the jobs for the various equipment and implements for the day; or make a requisition for supplies on a very short notice before they will be used. Research staff should be aware that

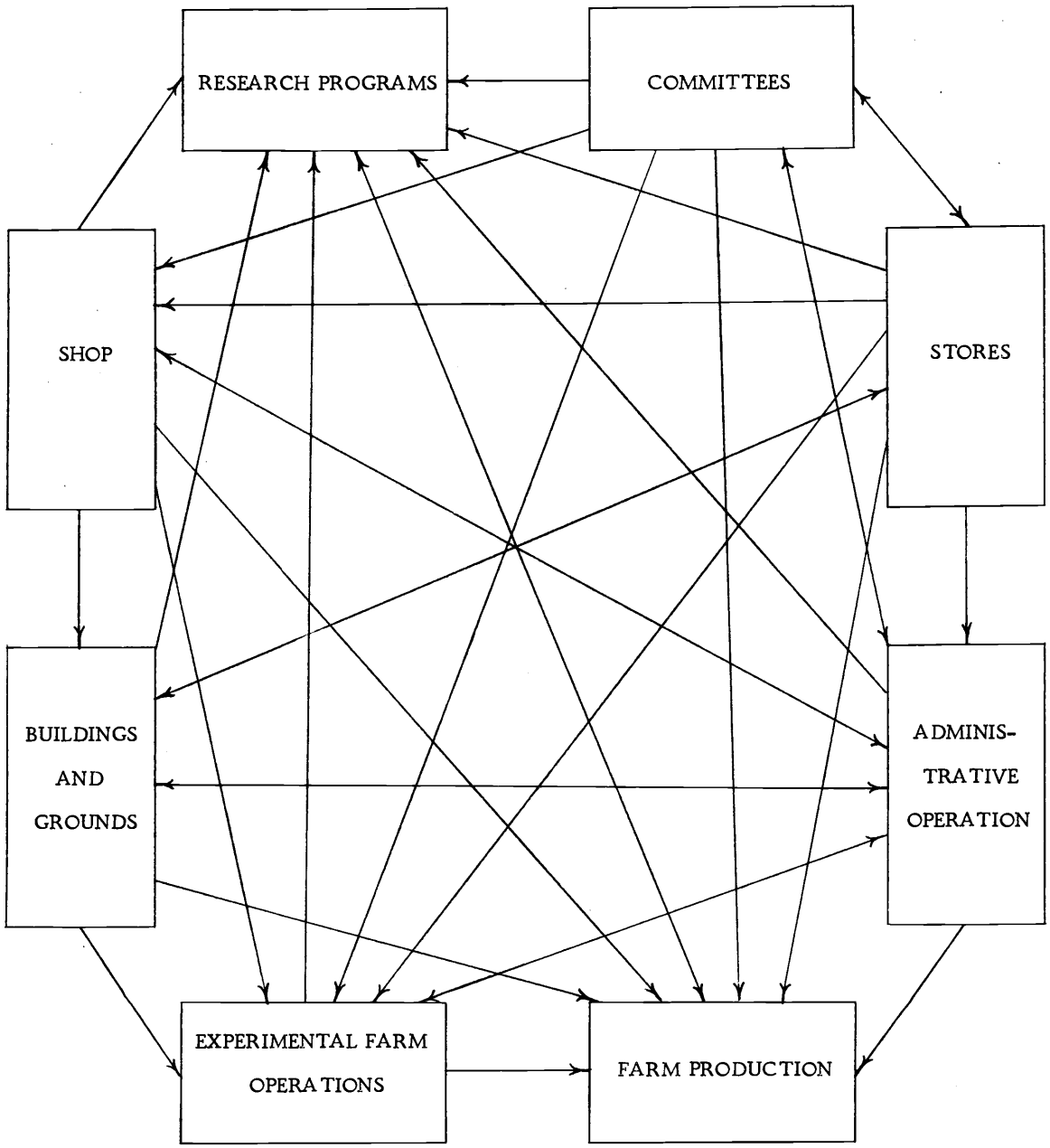

Figure 1. Relationship between research and services and among services.

services must be rendered on a first-come-first-serve basis and that according to this priorities must be set. If planning is important in a research program it is also important for the service personnel to be able to plan their work.

It is imperative that rules and regulations be clearly defined; the director must make sure that everybody understands them and appreciates them.

Efficient procedures must be designed. Their purpose must be to help the researcher do a better job not to hinder his efforts. If this happens then the procedures must be modified accordingly.

Figure 2 shows the experiment station responsibilities. Each unit has a head or chief and as many subordinates as needed. Only the head of each unit is directly responsible to the director, following the principle of the unity of command.

To sum up when a new experiment station is being organized costly organizational errors must be avoided. In an analysis of a contemplated organization structure, the point of departure must be the objectives of the station. The structure is the framework of action for implementing these objectives. Only positions which can make a contribution to the attainment of objectives should be created.

An experiment station regardless of its size, can effectively use certain long-established and recognized principles int its organizing activities.

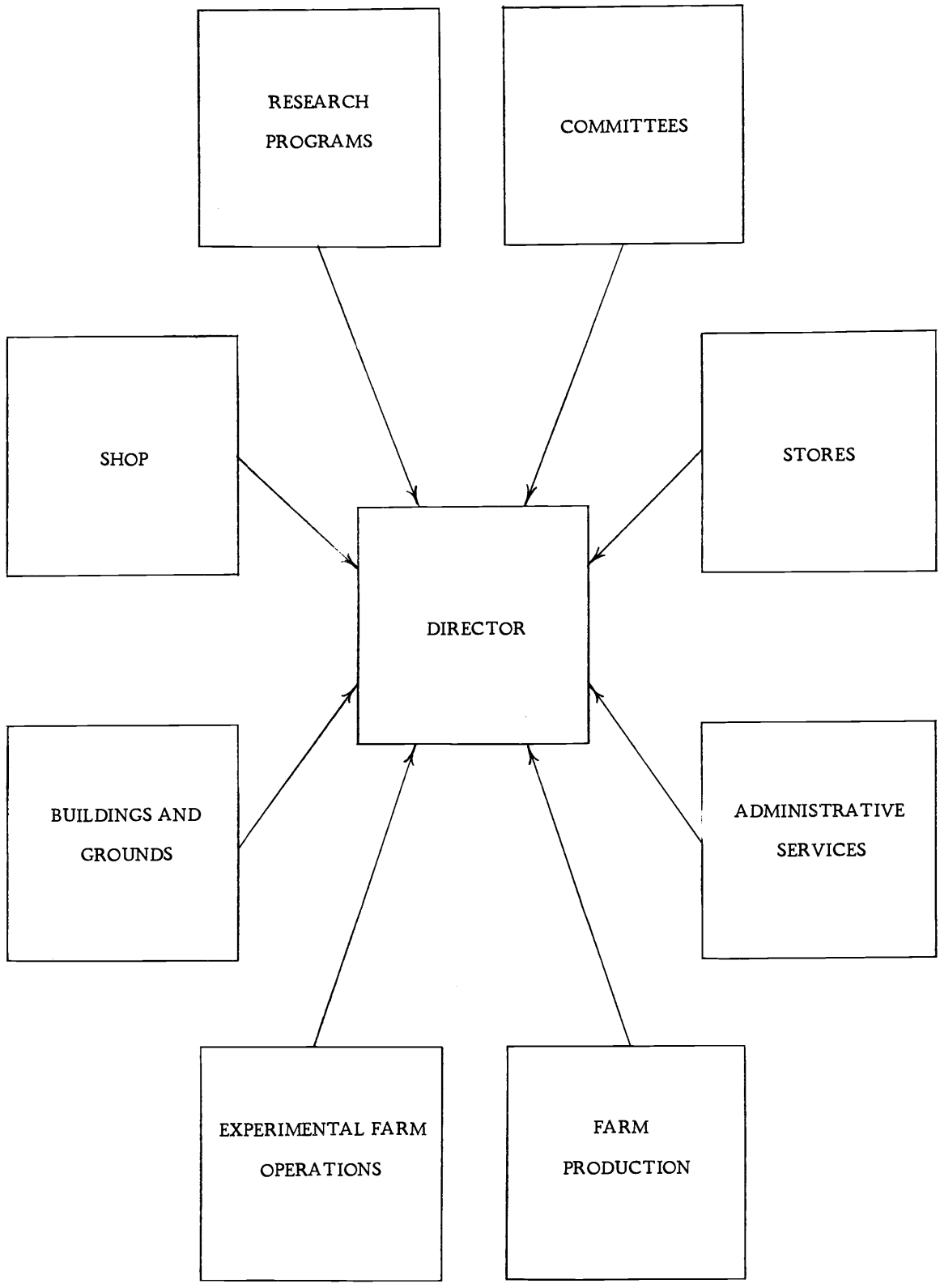

Figure 2. Experiment station responsibilities.

Constant evaluation of the organization, its structure and its people, is necessary to an efficient and effective agricultural experiment station.

STAFFING

In an agricultural experiment station as in any other organized activity the one indispensable ingredient is people. People are needed to plan, to frame the objectives, develop programs and carry them out. The human component of an organization is known as its personnel. Staffing is the function that pertains to recruitment, selection, hiring and training the personnel needed.

Although staffing is mentioned in this study after planning and organizing this does not mean that only after these two functions have been performed is staffing performed. In the case of a new experiment station that is being established staffing would come as a third step but afterwards the staffing function becomes a continuous process.

Extent of the Staffing Function

In order to define and clarify the group of employees included in the staffing concept here it must be stated that the staffing function is concerned with the placement, growth and development of all those members of the organization whose function is to get things done through the efforts of other individuals. For purposes of this study attention will be directed specifically to the selection, development and training of the director and heads of the various service units. Material on selection and development of research staff is not

included. However, some of the principles that will be discussed could be applied equally well to the research staff. To better understand what factors should be considered in staffing it is necessary to have a clear understanding of some basic concepts.

Organization Chart

A point of departure for the staffing function is the organization chart because it shows the type and number of positions that must be filled. The chart is the structural design of the organization. It should be clear and easy to understand showing the single and direct relationship between the superior and his subordinates. It is customary to use solid lines to show the chain of command and dotted lines to indicate advisory or staff relationships.

Some organization defects may be discovered when a good job of charting has been done. These should be corrected before the process of staffing is initiated.

Organization defects that may be found include the following:

1. The span of control may have been violated.
2. There may be improper stressing of the relative importance of functions. An important activity may be placed on a low executive level, while one less important is placed on an upper level.
3. Activities may be illogically arranged, resulting in

assignment of unrelated subdivisions to one and the same authority.

4. Unrelated functions may have been assigned to the same position.

5. Some activity may be entirely overlooked.

6. Relatively minor functions may be duplicated.

Comparatively few of the experiment stations visited have organization charts. This conditions is apparently due to lack of appreciation of the need and value of such charts, reluctance to indicate relative ranking of positions which might give rise to dissension or lack of personnel experience in making simple, effective charts.

In one particular station that did not have organization charts when the author asked various staff members to draw what they thought was their position in the organization, very few were able to do so.

The process of charting an organization plan is a good test of its soundness, because any organization relationship that cannot be readily charted is very apt to be illogical and confusing to those working under it.

Job Analysis

In addition to the organization chart it is necessary to have available written job analysis, which is defined as the process of

determining, by observation and study the nature of a specific job. It is the determination of the tasks which comprise the job, and of the skills, knowledges, abilities and responsibilities required for successful performance and which differentiate the job from all others.

In general there are but three parts to the analysis of any job:

1. The job must be completely and accurately identified.
2. The tasks of the job must be completely and accurately described.
3. The requirements the job makes upon the worker for successful performance must be indicated.

Job Specifications

The specifications derived as a result of the analysis are called the job descriptions or job specifications.

Specifications are statements that describe something about jobs. If they describe the job itself they are called job specifications. If they describe the kind of a person who should fill a given job they are called man specifications.

Job specifications serves the following important purposes:

1. It gives each job holder a clear conception of his proper part and relationship in the organization as a whole. This definition of just what is expected of him makes it

possible for him to concentrate his full energies and attention toward accomplishment of these specific objectives.

2. It affords an invaluable basis for "breaking in" new appointees and training them to meet the requirements of the job.

3. It provides a sound and logical basis for the periodic appraisal and rating of individual performances and capabilities, in terms of the requirements of the job.

In defining each job and writing its specifications to fulfill these purposes, it is desirable to consider the following points:

a. Basic functions

b. General objectives or responsibilities in terms of conditions which will be met when the job is well done.

c. Relationships with other units of the organization

d. Limits of authority.

Recruitment

Recruitment provides for the development of good sources of supply for the various types of personnel needed by the organization so that there will be an adequate number of applicants for all vacancies. It is the employment process up to the point of the making of the application.

There is not a definite ratio as to the number of applicants per position available, some firms have a general ratio of over ten applicants to each vacancy filled.

Sources of Supply

The most logical source of supply for the research positions are from the various local and national colleges of agriculture. This implies of course that the applicants will be men who are just about ready to graduate or have already graduated but who in any case will need intensive training in research.

For the service positions the supply is more abundant, therefore, proper selection should be the main concern followed by a well designed orientation program.

For some of the administrative positions the sources of supply tend to be rather scarce because it is difficult to find individuals with background in agriculture and with experience in administration at the same time.

Unsolicited Applicants

Several factors influence the number and quality of applicants who come unsolicited. First and most important is the reputation of the organization. This includes such factors as comfortable working conditions, loyalty and enthusiasm of the employees, pay and

personality of the people in the top positions. This is of no help to an organization that is just being established, however, it is advisable to keep this in mind because it will prove of value in the future when a large number of applicants will be necessary to do a good job of selection.

Selection

The selection procedure consists of ascertaining whether or not candidates possess the qualifications called for by a specific job. However, selection cannot take place unless three major steps have been taken:

1. Requirements of the job to be filled have been specified.
2. Qualifications workers must possess have been specified.
3. Candidates for screening have been attracted.

When these have been completed then selection can proceed by matching the qualifications of candidates with the requirements of the job. The undesirable candidates are screened out and the ones that are qualified are retained.

Given two or more candidates for a job, there is no absolutely sure way of selecting the best one. Whether the position is that of mechanic or director, the only tools available are examination of the information gathered on the candidates.

The efforts put in gathering information may be studied in terms

of the information which is sought and in the means of deriving desired information. The general classes of information sought include the following:

a. Training, experience and general background.

b. Mental ability and level of intelligence.

c. Physical conditions, aptitudes and skills.

d. Moral and emotional characteristics and skills.

e. Psychological and sociological aspects.

The means of gathering information include the following:

a. Application blanks, references and similar reports

b. Past records

c. Interviews

d. Tests and examinations

Past Records and Application Blanks

Practically every organization uses an application blank in which applicants are asked to list their education and past experience. Application blanks are one of the most common tools of selection. Although it varies from organization to organization the following general information is sought in almost all cases:

1. Identifying information, such as name, address, telephone number, and social security number.

2. Personal information, such as marital status, dependents,

age, place of birth, birth place of parents, number of sisters and brothers, etc.

3. Physical characteristics such as height, weight, health, defects.
4. Education
5. Experience, usually through the last three or four employers only.
6. References, personal and business.
7. Miscellaneous remarks and comments such as hobbies, membership in organization, financial status and insurance programs.

The application blank is seldom used as a sole basis for hiring. Its main purposes is to provide information for reference checking and good interviewing. Of course, when the application shows that the applicant does not have the training or experience required it may serve to reject him.

Interviews

Interviewing is one of the oldest forms of selection procedure and in most cases it carries the most weight. Many people believe that they can get a better idea of the applicant's total personality, including his intelligence and interest in the job, by face-to-face contact than in any other way.

There are some qualities that can be judged only in an interview, i.e., manner, neatness of appearance, ability to meet other people, etc. Where the interviewer is the man who will be the successful applicant's boss, he can gain some idea of how well they could work together.

One disadvantage with interviews is that in many cases the interviewer does not have the necessary background in psychology and techniques of interviewing as to conduct an effective interview. This suggests the need for careful selection and training of interviewers.

Tests

While it is reported that a great many organizations use them most places weigh on other factors such as interviews. Job analysis is essential in order to determine the skills, aptitudes, or other characteristics for which tests must be designed. Until this information is obtained, the selection of development of tests can only be based on guesswork. Tests should be developed with a view to particular jobs in a particular organization. Reliance should not be placed only on tests in reaching decisions. They are most useful when they are given a part in the task of selection and training of employees.

An important factor to keep in mind is that only the expert--the

psychologist, consultant or staff specialist--should be allowed to design, select and interpret them. This factor alone may put tests out of the reach of many organizations who do not have either the trained personnel or the facilities for testing.

Selecting the Director of an Agricultural Experiment Station

The director of an experiment station holds the most important position in the organization. As such his decisions are of enormous significance to the research, administrative and service activities of the station.

This position proves to be one of the most difficult to fill because it requires a man with special qualifications and training. Some background information on the subject will help to understand the problem.

The staff of any agricultural experiment station is composed of investigators or researchers specialized in various areas of agriculture and science. They all hold university degrees and many hold Master's and Ph. D. degrees. In Latin America they are all responsible to the experiment station director. In the United States they are responsible to their department head.

The research staff work in different programs or projects, each being composed of a program head and two or more staff subordinates. It is usually from the program heads or research staff that the

director or superintendent is chosen. The decision is generally based on the scientific achievement. Here is where the problem lies. While it is true that the candidates for director are qualified and have distinguished themselves in their field of work, it may also be true that they usually have little experience or training in management, administrative procedures, personnel management, human relations, etc.

This is a good example of the Peter Principle (20) which states that: "In a hierarchy every employee tends to rise to his level of incompetence." Peter (20) adds that for each individual the final promotion is from a level of competence to a level of incompetence.

In the case of the experiment station it is thought that a very competent research staff member would make a successful director. However, what it actually happens is that the researcher is promoted from his level of competence to his level of incompetence. Some individuals may be aware of this but still they accept the job when offered because of two reasons, mainly: a) like in any other organization administrative positions pay more, and b) because of the prestige of the position. In other words to satisfy the ego needs of recognition and autonomy.

The question is then what can be done to prevent a competent researcher from becoming, when so promoted, an incompetent director. One solution is to make available the necessary training.

However, what kind of executive he will make depends upon what he does make himself management material. With training available he must be willing to learn and study in order to be able to fulfill the requirements the job of a director demands.

Of the many directors or superintendents interviewed by the author in Ecuador, Colombia and in the United States all stated that when they were first hired they did not have the training needed for the job and that therefore their first actions were based on trial and error. They all expressed the need of training for the job. Most of the superintendents interviewed have been in the job now for more than ten years and thus have become experts in the field. However, there is very little training available for experiment station management even though some of the superintendents interviewed will be retiring in a few years and replacements will be needed.

If there is need for such training in the U. S. the need is even more urgent in the developing countries whose economies are primarily agricultural because it is in these areas of the world where more new experiment stations are being established at an increasing rate.

In general it is felt that a person aspiring to be director should be a generalist rather than a specialist. Besides his formal training in agriculture and research it is felt he needs training in the following areas:

a. In administration, including:

Principles of organization. Organization plan of experiment stations; the distinction between responsibilities and relationships of research, administration and services.

Personnel administration: promotion; disciplinary actions; handling of complaints and grievenaces; and similar matters.

Cost control: budget and financial affairs; records; inventory, etc.

Human relations, public relations

b. In agricultural engineering

First hand experience in farm machinery usage and farm machinery maintenance.

Development and planning of experiment station buildings; environmental control: design procedures for environmental control; remodeling.

Basic principles: usage and maintenance of electrical transformers; wiring; control systems, safety devices; motors.

Irrigation: principles, systems and equipment.

Drainage: principles, systems and equipment.

In no case should a nomination for director be made on a final

basis. It is of more benefit for the station and for the individual that he should first be named acting director and only after a reasonable period in which his performance can be appraised should the final nomination be made.

This is especially important in the cases where the candidate is one with no experience in administration. It may turn out that after a month or so he decides that he does not like the job so he has to go back or step down to his old job and salary. This is bound to affect him emotionally in his future performance. If he has been only acting director this would be less likely to occur.

In the case of a new experiment station this seems to be the only reasonable way to go about filling the position of director until the right person is found or until someone is sent for training to another experiment station locally or in another country.

All efforts should be used to get someone trained or to send someone for training because the operation and future of the experiment station depends on this.

Following are sample listings of responsibilities and duties of: a) director of an experiment station, b) chief of experiment farm operations, c) chief of stores, d) chief of building and grounds, and 3) chief of the shop. These were designed by Calhoun (4) and the author for the experiment stations of the National Institute of Agricultural Research of Ecuador as part of a program of reorganization of the

station initiated in 1967. The same could be applied to almost any experiment station with a few minor changes or additions according to the particular characteristics of the station.

Responsibilities and Duties of a Director of an Experiment Station

The director is responsible for:

1. The organization, operation and management of the experiment station.
2. The delegation of responsibilities and authority to personnel according to the most efficient system of organization of the station and the most effective use of personnel.
3. The development and administration of policies and procedures necessary for the effective and efficient operation of the station in accordance with the policies, procedure and regulations established.
4. Becoming familiar with and the administration of all policies, procedures and regularities of the station and all pertinent national laws.

The above described responsibilities would include:

a. The discipline and morale of all personnel at the station.
b. Develop and encourage an effective means of communication among all personnel at the station.

c. Provide a climate conducive to, and an opportunity for learning, growth and development of each individual towards maturity and increased competency in skills and knowledge in research, research services and administration.

d. Guidance and direction to research personnel as needed, in the planning, conducting and reporting of all research at the station.

e. An adequate and efficient system of accounting, record keeping and property control, in the acquisition and/or disposition of all materials, supplies, machinery and equipment as needed in the effective operation of the station.

g. The prudent use of all vehicles, machinery, equipment and facilities assigned to the station.

h. A vigorous program of maintenance, repair and upkeep on all vehicles, machinery equipment and facilities.

i. The labor management of all personnel at the station in regard to hiring, firing, time off, and pay increments. Except in case of classified personnel that the director can only recommend.

j. Maintenance of good public relations at all times in regard to all aspects of the station and personnel.

Responsibilities of the Chief of the Experimental Farm Operations

The chief of the experimental farm operations is responsible for:

1. The assignment of all land to research program as well as to production operations.
2. Providing adequate and efficient field services to all research programs according to their needs. This would include such services as seed-bed preparation, fertilizing, spraying, irrigation etc.
3. Determining the rotation of crops and all fields of the station as well as maintaining records for each field as to kind of crop, all cropping practices, fertilizers and any soil amendments applied and herbicides and insecticides used.
4. The operation and maintenance of all irrigation systems including pumps, pipe, sprinkler, valves, ditches, ponds and wells.
5. The construction, operation and maintenance of an adequate drainage system in accordance with the best principles of soil conservation practices.
6. An effective and systematic method of weed control on all cultivated lands and on all roadways, fence rows and

non-cultivatable land.

7. The construction, repair and maintenance of all roads, fences, gates, corrals and similar farm structures.

8. The forestry operations, if any, on the experiment station. This would include reforestation on all non-cultivatable lands and the harvest and dispositions of this timber.

9. The supervision and efficient utulization of all labor needed in the performance of previously described responsibilities.

10. The training of all personnel as needed in the skills essential in the performance of previously described responsibilities.

11. The requisitioning of any material, supplies, machinery and equipment in accordance with policies and procedures for purchasing as needed in the performance of previously described responsibilities.

12. Any other responsibilities that the director may deem necessary from time to time.

Responsibilities of the Chief of Stores

The chief of stores is responsible for:

1. The procurement of materials, supplies, machinery and equipment for all research program and all research

services of the stations. This includes:

a. Initiating requisitions for any items in stock as requested by authorized personnel.

b. Maintaining a reasonable supply of commonly used items in the warehouse.

c. Keeping an up to date file on all items in stock in the warehouse as to description, quantity, price and name of personnel requesting items.

d. Notifying personnel as to the availability of items they requested as soon as possible after the items have arrived on the station.

2. The control of all inventory property on the station. This includes:

a. Assigning inventory property to authorized personnel who must sign for and thereby accept responsibility for this property.

b. Make a physical inventory of all inventory property on the station as to quantity of items, description of items, inventory value and disposition.

3. The organization of the stores in such a manner as to provide efficient and effective service to all station personnel according to their needs.

4. The supervision of personnel in their performance of

above described responsibilities.

5. The training of personnel as needed in skills and procedures essential to the performance of above described duties.

6. Any other responsibilities that the director or immediate supervisor may deem necessary from time to time.

Responsibilities of the Chief of the Shops

The chief mechanic is responsible for:

1. The maintenance, repair and overhaul of all vehicles, tractors, machinery and equipment on the station. This includes:
   a. An effective system of preventive maintenance for all vehicles, tractors, machinery and equipment.
   b. An efficient system of repair and overhaul of vehicles, equipment or machinery.
   c. The maintaining of a permanent record on each vehicle and tractor as to its maintenance, repair, mileage or engine hours and other pertinent data.
2. The organization and the operation of the shop so as to give adequate and efficient services to authorized personnel according to their needs.
3. To provide an effective method of control over all tools and spare parts used in the shop operation.

4. Providing an efficient system of dispensing gas, oil, diesel, air and water as well as the lubrication, cleaning and servicing of vehicles and tractors.

5. The construction, remodeling or alterations of any machinery, equipment or gadgets as needed by station personnel.

6. The operation, maintenance and repair of all electrical generators on the station.

7. The supervision of all personnel in the performance of the above described responsibilities.

9. Requesting of any materials, supplies, machinery and equipment in accordance with policies and procedures for purchasing as needed in the performance of above described responsibilities.

10. Any other responsibilities that the director or immediate supervisor may deem necessary from time to time.

Responsibilities of the Chief of Building and Grounds

The chief of buildings and grounds is responsible for:

1. The preventive maintenance and repair of all buildings and facilities on the station. This would consist of:

   a. Systematic program of painting of all buildings and facilities both inside and outside at least once in

every three to five year period.

b. Preventive maintenance and repair on all electrical systems as needed except for the electrical generators.

c. Preventive maintenance and repair on all plumbing facilities, sewage facilities and domestic water systems as needed.

d. Systematic program of preventive maintenance and repair on all roofs, floors, doors, windows and ceilings in all buildings as needed.

2. The remodeling of present buildings and the construction of any new buildings and facilities except for those under contract or the direct supervision of the office of planification.

a. The design and layout of all remodeling and/or construction of any new buildings must be approved by the director and/or office of planification.

b. All construction shall be in accordance to approved standards and specifications as determined by the office of planification.

3. The operation of the carpenter shop. This would consist of:

a. The maintenance and prudent use of all hand tools

and power tools assigned to the carpenter shop.

b. Providing a service to all station personnel as needed in the construction of any articles of wood and/or similar materials.

c. Providing assistance in the remodeling and/or construction of new buildings and faciltiies and the maintenance and repair of all buildings.

4. Providing janitorial service for certain buildings. This would consist of:

a. The daily cleaning of all floors in all designated buildings.

b. The daily cleaning of all bathroom facilities and sinks in above described buildings.

c. The daily dusting and cleaning of furniture fixtures, cupboards, and window sills in above described buildings.

d. The periodic waxing and polishing of floors in above described buildings as needed.

e. The periodic cleaning of all windows in above described buildings as needed.

5. The landscaping and maintenance of the grounds around all buildings on the station.

a. The landscaping around all buildings, main

entryways and driveways.

b. The systematic maintenance of all landscaping, lawns and greenways around all buildings on the station.

6. The operation and maintenance of the greenhouse, headhouse and its facilties. This would consist of:

a. The operation of greenhouse, headhouse and facilities.

(1) Daily watering of plants as per instructions.

(2) Effective insect, disease and weed control methods.

(3) Operation of temperature controls as per instructions.

(4) Operation of soil sterilization equipment.

b. The preventive maintenance and repair to greenhouse, headhouse and equipment.

7. The supervision of all personnel in their performance of the above described responsibilities.

8. The training of personnel as needed in the skills essential to the performance of the above described responsibilities.

9. The requesting of any materials, supplies, machinery and equipment in accordance with policies and procedures

for purchasing as needed in the performance of above described responsibilities.

10. Any other responsibilities that the director or immediate supervisor may deem necessary from time to time.

BUILDING THE EXPERIMENT STATION

The actual construction of an experiment station is a decisive factor in its establishment. It is the point at which the plans have to be implemented and put into action.

This is by no means an easy task. There are many factors to take into consideration, all important and all will contribute one way or another to the operation of the station.

There are not any set rules or established principles that can be used as guides. The concepts presented here are not the final word to follow in the actual building of an agricultural experiment station. But they should serve as a guide or point of reference where to start. Some of the ideas here presented are just plain common sense. Others are the result of many years of experience of men that are presently holding positions as experiment station directors or superintendents.

Location

It is generally agreed that the location of the experiment station should be in the area it is designed to serve. This means that the weather and the soil must be representative of the zone. Mosher (18) states that an effective research program must combine two activities strategically located in the country: (1) one or more comprehensive

experiment stations each located where soils and climate are representative of an agricultural region of high potential, and (2) many field trials scattered through many farming locations. He further states that major experiment stations need to be located in a place having approximately the same soil and climatic resources as large areas of the good agricultural land of the country with access to markets and to farm equipment and supplies.

He also mentions that too frequently a central research station is located near the capital city for ease of administration by someone from the Ministry of Agriculture. While this may be true there also exist the cases where experiment stations are built in rather remote places of rather difficult accessability where the cost of providing services and facilities are almost prohibitive. When possible this latter kind of situation should be avoided.

When the area the experiment station is to serve has been determined the question becomes one of locating the most suitable land. For this the following factors must be carefully studied:

1. Soil uniformity: Uniformity must be interpreted very widely in selecting an experimental site. The subsoil must be investigated and a number of samples must be taken for analysis.

   There are a number of indicators of soil uniformity. Salmon (25) indicates that no one of the soil indicators

is completely reliable but that they may be used with discretion. Some of his suggestions are:

a. Avoid farms or fields that vary markedly in topography. A slight and gradual slope is desirable in order to assure adequate drainage. Steep hillsides are seldom satisfactory because of heavy erosion and differences in production usually associated with position on the slope.

b. The visual appearance of a growing crop may often indicate marked differences in productivity. Since such differences may appear in some years but not in others, or with some crops and not others, observations for several years and with several crops are advantageous. In a newly-settled area, the kind and development of the native vegetation is a useful index of variation.

c. Examination of the soil and subsoil previous to choosing an experimental field is always desirable. Fields with different soil-types should be avoided as far as possible. Gravel or sand-beds beneath the surface, are especially objectionable. A complete soil survey of areas intended for field experiments is always desirable.

d. Fields, some but not all parts of which have been heavily fertilized in the past should be avoided. The same applies to treatments with any other material, certain insecticides and herbicides for example, which remain in the soil for several years.

e. For experiments with grain crops, it is usually advisable to avoid fields near trees because of possible damage by birds. Also trees rob the soil of moisture and plant food for a considerable distance into the field.

f. As far as possible, fields which have been covered or portions of which have been covered, with subsoils from borrow-pits or drainage ditches should not be used. The subsoil may have a marked effect on yields for several years.

Wishart (34) feels that some people consider soil uniformity no longer important because they imagine that soil inequalities will come out in the statistical results. But he says that that is not true because the strength of modern methods is that they protect the experimenter from drawing wrong conclusions when differences are merely due to soil irregularities.

The more even the soil the greater will be the efficiency of the

experiment. Even with the greatest care, the area chosen is certain to be more or less variable. There is no such thing as a perfectly uniform field; only degrees of non-uniformity. This variation is of two kinds--(a) fluctuating variation from plot to plot and (b) a more or less gradual change in productivity from one portion of the field to another. The latter is more serious, but can often be avoided to a considerable extent by careful choice of the experimental area, or if the choice is limited, the effects may in part be eliminated by suitable experimental designs (25).

A more formal, and generally more useful way to determine the suitability of a field for experiments is to conduct a uniformity trial. Unfortunately this is usually not possible to do on a piece of land that has not been purchased yet.

2. Topography. Topography is always important, not only because it is related to productivity, but also because it affects the water-supply in the soil, temperature, and air drainage. Slope of the land may affect soil erosion, and direction of slope may be important in relation to the sun's rays and warming of the soil in the early spring.

Calhoun (4) feels that as much as possible the land should be flat to be able to have a better control of the total environment. Rhode (23) states that a very detailed survey of the area should be conducted. And that information should be obtained from the local

extension agents and also from leading farmers who very probably know of any special problem characteristic of the land beind considered.

3. Water supply. Availability of water should be assured before a final decision to acquire the land is made. This is important not only from the standpoint that irrigation will be needed but also to satisfy the domestic needs. Assurance that there is enough underground water is not sufficient, if possible a sample should be obtained for chemical analysis. The author is acquainted with a situation in which many water wells were drilled which produced an enormous amount of water but upon chemical analysis it was found that the exceedingly high content of iron would have caused a tremendous effect on the soil if the water had been used for irrigation.

The use of stream water or low volume rivers should be carefully considered. As a result of people washing containers of chemical herbicides or insecticides in the river waters its use is becoming more restrictive and prohibitive for irrigation of experimental plots.

Ross (24) stated that he would not set up any experiment station unless there was a good source of water both for domestic and research use.

4. Distance from nearest city. How far the station will be located from the nearest city will have effect on the station in two respects:

   a. From the standpoint of services and supplies it means that the greater the distance the more complete will have to be some of the services like the shop for instance.

This is closely connected with the type of roads that link the station with the nearest town. If the roads are not very good the distance problem is enhanced. Larger storage facilities will be needed and consequently a larger inventory must be on hand in order to have available the most urgent supplies.

Another problem connected with this lies in the improbability of being close enough to power lines, therefore another expense must be contemplated: an electric generator which means more expenses in fuel, maintenance and spare parts plus the added inconvenience that certain experiments requiring illumination or refrigeration 24 hours a day will be too costly to perform because the generator will have to be operating continuously and part of the time with a partial load, thus losing efficiency.

   b. From the human standpoint the effect that isolation has on the personnel of the station and on their families is very serious. Lack of schools, churches

and shopping facilities is an obstacle that prevents capable research individuals from wanting to work under such conditions.

If the funds are available there is the possibility that such a station could be provided with as many facilities and conveniences necessary. However, research institutions are usually financed with public funds which are always in short supply, therefore the establishing of an experiment station in such conditions must be weighed by against the possible benefits that can be obtained and the impact that these will have in the zone. Finally, stations should not be situated too close to a city for the simple reason that as the city grows it would start surrounding the station thus preventing its possible future expansion.

Facilities Needed

The size of the station and the kind of research to be performed will dictate the facilities that will be necessary. In any case, a list of priorities should be made. Calhoun (4) feels that a shop should be high in the list, then storage for machinery and supplies followed by some inside work space and finally offices and laboratories if needed. Ross (24) stated that the working areas like the shop should be given preference, that it would be better to cover the machinery with plastic but have a decent place to work.

To the question of whether research activities should be started before facilities are available most of the directors interviewed agreed that there should at least be a minimum of facilities and that when possible these should be developed to the point where they can provide adequate services to research.

The following facilities may be considered when establishing an experiment station:

a. Roads: main and secondary

b. Water: domestic and for irrigation; sewage disposal

c. Electric power: from power company or from generator

d. Machine shop and carpenter shop with the necessary tools and equipment

e. Storage facilities for: research supplies like fertilizers, herbicides, tools and implements; machinery and equipment; for fuels and oils

f. Work spaces open and with a roof for threshing, cleaning, weighing, etc.

g. Greenhouse

h. Cold storage rooms

i. Growth chamber

j. Barns for: dairy, beef, sheep, poultry, etc.

k. Hay and feed storage barns

l. Silos

m. Grain and forage dryers

n. Tractors, seeders, seed bed preparation and harvesting equipment, etc.

o. Offices and laboratories

p. Library and/or conference room

q. Cafeteria or dining facilities

r. Ample parking spaces.

Buildings

Before any buildings are started a complete master plan showing the immediate as well as the future needs should be prepared. Such master plan should be flexible enough so that adequate changes can be made when necessary. This is fundamental. The result of a lack of a master plan in many experiment stations is a complete chaos where buildings are put up with absolutely no concept of utility and efficiency.

This is another reason why a superintendent or director should be acquainted with design. For larger buildings he should seek professional help but even so he should have quite a bit to say because as Ross (24) stated most architects and engineers have had little or no experience in designing and constructing buildings for experiment stations.

Very few are the stations that have a master plan and very few

also the ones that after the buildings are put up have a map indicating where the network of the water system is or where the electric wires go through. Thus when an extra faucet or an additional outlet is needed in a laboratory it is necessary to tear down almonst one whole wall.

The master plan should also indicate the exact locations of each building in other words the complete layout, in order to see their location in relation to the overall experiment station and be able to plan accordingly for the future expansion.

There are certain steps that ought to be taken from the time the idea of a building is first conceived until its final completion. These steps should be considered in logical sequence as follows:

1. The need for the building must be determined.
2. The economic feasibility of the building must be determined in relation to the services it will provide.
3. The building must be planned and designed in detail.
4. Construction of the building according to the detailed plans.

The location of the building compound within the experiment station is very important. Should the buildings be constructed in an area of the farm where the soil is less desirable for field research? To this question the majority of the superintendents interviewed replied that the buildings should be located as close as

possible to the center of the farm. The reason being that from such a location a more efficient service is provided. Besides the distances that the equipment must travel for field work would be shorter from such locations, or if a tractor has to get back to the shop for a minor repair or adjustment less time is lost in travelling from the field and getting back.

The distance from the main highway to the buildings should be from one-half to three-fourths of a mile in order to avoid traffic noise. But considering at the same time that utilities such as electric lines and telephone lines commonly follow along the highways and roads. The further from the highway the buildings, the greater is the expense of providing these utilities to them.

The shape of the layout should be square for a more efficient utilization of the land, keeping in mind that each building should be able to be expanded.

Distance between buildings should be ample for normal traffic. Where there is no traffic distance should be sufficient to provide enough ventilation and light (4). Fire protection must also be considered in this respect.

Offices and laboratories must be built so that they are protected from fumes and dust from nearby buildings, noise level must be considered. This means that the shop, for instance, should not be built next to the offices and laboratories. In other words exact

location of each building depends on its usage or what is designed for. Prevailing winds should be considered in locating buildings. Climatic conditions will determine the most desirable orientation. This is extremely important, since sunlight is one of the most potent enemies of dirt and disease. As much as possible also orientation should be such as to make proper use of all available sunlight at all times of the year. In warm tropical countries the need for ventilation and cool temperature will determine not only the orientation but also the type of construction.

In general the type of building will be determined by the materials available and also the funds on hand. In any case, it is more desirable to have less buildings but with adequate utilities than lots of buildings but lacking running water and electricity, etc. (4, 23, 24).

In planning the various buildings it is necessary to seek the opinion of the people who are going to use. The architect should be fully aware of what are the needs of the people and there should be a clear understanding between them as to the exact location of certain facilities. In many instances it will be necessary that the staff member know the dimensions of the equipment he will be using. In the discussions should take part also the electrical engineer or the person responsible for designing the electric wiring.

Even after the planning is completed and during the process of building the director superintendent should check periodically the

progress made and should not allow any changes that may seem necessary until it is agreed by the people involved that such change will not be detrimental to the utility of that portion of the building.

In experiment stations where there will be research with livestock, the direction of the wind must be taken into account. Corrals and barns should be so located that no odors are flowing to the other buildings.

Roads

Roads are a key component of an experiment station. Their main objective in service to the field research in the sense that they serve so that the equipment and implements can be transported to the research fields. Roads are also needed to transport materials and supplies like fertilizers, seed, sacks, etc., and for taking the harvested material to the buildings to be weighed and dried, etc.

For an efficient service the road system must be properly designed. Roads can be classified into primary or permanent and secondary. Primary roads should have a paved or a gravel surface. The initial cost of paved roads is high but their maintenance is inexpensive. Gravel roads are expensive to maintain.

Secondary roads may be grassways, and are 30 feet wide from edge of field to edge of field. Their use is mainly to allow implements' entrance to the fields. The width is ample enough to allow

equipment to turn and to allow for ditches (26). Grassways should be higher than the fields, and should be given a crown. Roads along fences should also be grassways. Proper drainage is fundamental for good and lasting roads.

In an average size station it should be figured that about 20 to 25 percent of the land will be used for roads, ditches and buildings to adequately service the research areas (4).

Experiment Fields

To determine the best size and shape of fields for field-crop experiments is a complicated problem because it depends on many factors. These include the variability of the soil; whether the field operations will be done by hand or by machinery, relative costs, etc. Many of these problems are interrelated so that the solution of one of them depends on the other.

Experimental fields are seldom less than 500 feet long and are often 100 feet wide. Calhoun (4) stated that under his condition fields should be 1000 feet long and 150-200 feet wide. Wishart (8) feels that if an experiment station is to be run normally the experiments on it must only occupy a small proportion of its total area. Two advantages that derive from this is that it will make it easier to avoid the sites of recent experiments, and it will generally mean that the plots will be surrounded by considerable areas of the same crop; this

latter is important because small isolated patches of a crop invariably suffer from a variety of depredations.

Beyond what has been indicated, no generalizations seem desirable. The best solution will be reached through an understanding of the numerous factors concerned, taking into account the objectives of the research program and the conditions under which it is to be conducted.

OPERATION AND MANAGEMENT

This is a most important element in the overall activities and operation of an experiment station. Before deciding upon a system of management a careful study of its advantages and disadvantages is recommended. A system effective in some stations would not necessarily be applicable in another. Local customs and traditions must be taken into account as well as the social and political characteristics. However, the basic functions and activities are in general common to every experiment station. This implies then that even though the titles of the various positions may vary from one country to another the activities and responsibilities remain basicly the same.

As a whole the most efficient system of management is that in which the director or superintendent is responsible for the station's operation on a full-time basis and is given the necessary authority to organize it in the way he sees fit. But to be able to do this he must have the proper education and background. It was mentioned that he needs to be a generalist rather than a specialist. Besides his understanding of research he should have a general knowledge of agriculture engineering, psychology, human relations, business and personnel administration.

The management of an experiment station can be considered under two broad areas: 1) management of the land and facilities of

the station, and 2) management of the services. A third important area which will not be covered in this study is that of the personnel management. The director of the station should consult appropriate references and be familiar with the general principles that are involved.

Management of the Land

The first problem to solve is that of land allocation to the various research programs. This means dealing with people for whom each of their individual experiments is very important, and who have different land needs.

One practice that is reported to give excellent results is to request four or five months in advance that the program heads submit their land needs for the next coming year. Then the program heads with the superintendent have a meeting in which the superintendent indicates the amount of land requested and what is actually available. This way the allocation is done with consensus rather than by the sole decision of the director.

Each program then is allowed to determine the rotation of their land. The superintendent would make suggestions in this regard only if he feels that is necessary. It is felt that most of the programs do a good job of utilizing the land. Another advantage with this method is that the programs do not have to worry about what land they will

get next year and thus can plan work for many years. Temporary allocations are made for short term or unexpected needs such as seed increase, thesis problems, etc. (4).

If after the station is established the need arises for more land, all efforts should be made to purchase land that is close to the station because every extra mile from the main station will add up to the cost of operation.

Fields intended for experiments should be uniformly tilled and cropped when not actually in experimental plots. In general, two or more fields should be available for fertilizer, variety, seed-treatment, rate and date-of-seeding experiments, etc., so that while one field is in experimental plot the others can be cropped uniformly and preferably in a definite crop rotation (25, 4).

The land should be leveled gradually if it needs leveling moving only a small amount of soil at one time, this way the harmful effect of the exposed subsoil and of filling in small depressions will usually be less than the benefit from leveling (25).

Finally it is imperative that a very detailed history of each field be kept in order to do an intelligent job of land allocation and crop rotation. The program heads should report to the superintendents the name and amount of chemicals used and the date of application. Cultural practices used and the crops grown must also be reviewed.

Management of the Services and Facilities

It is the responsibility of the director of the station to organize the services and facilities. This involves defining the duties and scope of responsibilities of each unit or section, hiring the most qualified personnel and provide the proper training when so required. The management of the services then becomes a job of coordinating the various units in order to serve the research programs with the least waste of time, effort and materials.

The services will not be able to operate adequately, however, unless they have the support and understanding of the research staff. This means that the procedures and rules and regulations should be complied with by everybody.

It is also necessary that the services be provided with the proper tools and equipment and a schedule for gradual replacement or purchase is needed. Proper records of maintenance and repair must be kept on all machinery, equipment and vehicles.

Those who used machinery and equipment should be required to know how to cperate it properly and use it in a prudent manner.

All research programs need to have a list of all the equipment that they may use at one time or another. Such a list must include certain specifications, and general description such as horsepower of each tractor, cutting width of mowers, spacings of cultivators,

capacity of sprayers, etc.

In some experiment stations the use of the equipment and the labor is charged on an hour-rate basis to the individual research program's fund, in others it is charged to the general operating funds of the station. The type of system to adopt will depend on the budget policy and procedures of the larger parent institution which in turn is governed by the national laws. In general, however, each research program should know of the funds allocated to it and should be informed of the expenses it has made. This will help the program heads to plan their research projects accordingly and to make efficient use of the funds allocated to them.

CONCLUSIONS

Agriculture is the most important "industry" in many of the developing national economies. For this reason the funds allocated for research are being increased in order to provide manpower, land and facilities in the form of experiment stations.

Unfortunately, problems in the planning and organization of many experiment stations result in an inefficient use of the funds and resources available.

Some reasons which can be cited for this are:

1. Inadequate and scarce sources of information as to how to plan, organize and operate experiment stations.
2. Not a clear understanding and appreciation of the role of the administrative and service activities in the station and their impact on the quality and quantity of work and morale of the researcher.
3. Lack of coordination between the research and service activities. Coordination is required if the available resources are to be used efficiently.
4. Lack of trained personnel for the position of director.
5. Lack of formal training programs not only for directors but also for the personnel in the administrative and service units.

Considering that the number of experiment stations is increasing and that many of the already established ones are expanding their research activities the need for efficient organization and operation of the services and facilities is imperative. Along with this it is necessary to design formal training programs and workshops for the personnel in charge of the management and operation of the experiment stations. It is the duty of the station director to keep similar records on the expenses of the experiment station maintenance and operations.

Finally, it is recommended that some form of evaluation of the system of management, policy matters, and services and facilities be conducted periodically in order to find out if deficiencies exist or if changes are necessary. The results should be carefully studied and proper action taken to correct problem areas. If actions designed to improve the situation are not taken the evaluation becomes worthless and will affect negatively the morale of the personnel.

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