Translations and Reprints No. 15

January, 1975

the field support functions of the agricultural experiment station in the developing countries

C.R. Pomeroy

CENTRO INTERNACIONAL DE MEJORAMIENTO DE MAIZ Y TRIGO
INTERNATIONAL MAIZE AND WHEAT IMPROVEMENT CENTER
Londres 40 Apartado Postal 6-641 México 6, D. F., México

FOREWORD

A basic requirement of any agricultural research station is a well organized and managed experimental farm. In the past, agricultural research in India had suffered badly due to inadequate attention to this vital need. Following the initation of the All-India Coordinated Maize Improvement Project in 1958 by the Indian Council of Agricultural Research in collaboration with the Rockefeller Foundation, serious attention began to be paid to improving facilities for conducting practical field experiments. Until a few years ago, the yields obtained even in experiment stations were so poor and the coefficient of variability in field experiments so high that it became very difficult to assess the value of new genotypes and agronomic practices with confidence. Many variables such as considerable heterogeneity in soil fertility, poor leveling, inappropriate tillage, uncertain and improper irrigation and heavy weed competition all made it difficult to get consistent and reliable data from field experiments.

Farm management is a specialized skill. Those involved in it perform a service function. Unless such staff are properly trained, organized and supported it would no be possible to get the best from them. During the last five years an attempt has been made at the Indian Agricultural Research Institute to develop an integrated and efficient farm operations and management system. Mr. C. R. Pomeroy of the Rockefeller Foundation has been closely working with the staff of the IARI in this program and has been instrumental for much of the planning of the farm development and irrigation system. Therefore, this article of Mr. - Pomeroy is based upon considerable operational experience. The IARI proposes to start training courses in experiment station management soon and this article would be found to be of very great value by the trainees who will be participating in this course. It will also be of much value to all agricultural research workers, administrators and others connected with the establishment of a research farm and the laying out of field experiments.

M. S. Swaminathan
Director

Reprinted from: Journal of the Post-Graduate School, Indian Agricultural Research Institute, New Delhi, Vol. 8, No. 1, June 1970.

THE FIELD SUPPORT FUNCTION OF THE AGRICULTURAL EXPERIMENT STATION IN THE DEVELOPING COUNTRIES

C. R. Pomeroy *

1.1 INTRODUCTION

Research programs, whether they be in agriculture, medicine or zoology might be thought of as consisting of two basic ingredients: the men, the experimenters conducting the research; and the facilities with which or in which their work is done. Many things go into the preparation of the men for their part in a research program. Likewise many things must go into the preparation and operation of the facilities to support the experimenters in the conduct of their work. "Facilities", in the broad sense used here, include funds, administrative systems, buildings, laboratories, libraries, etc. and field support.

Of all of these elements that must be combined in their varying proportions to produce satisfactory facilities for good agricultural research, probably the most neglected, misunderstood, mismanaged, and misused in the developing countries is the element of field support; that is, the land and the systems and people that are associated with the land, Yet the land and its associated systems and people are the common foundation upon which all field research programs are built.

Quite often the research staff of various organizations in the developing countries are the academic equals of their counterparts anywhere in the world, at least within the rather narrow confines of their parent academic discipline. And they should be. They usually have been educated in the best schools in the world and are ready and able to contribute their share of high quality agricultural research.

However, more often, at least this one highly important part of the facilities foundation upon which this research work must be based, the field support function, or the use of it, does not measure up to the same high standards.

A very broad gap usually exists between the academic capability of the experimenter and the physical performance capability and the persons and systems that actually carry out the numerous physical tasks associated with field research. A long chain of interrelated ideas, people and activities must be put together properly to produce good field research. One of the main links in this long chain is the experimenter who is probably highly motivated and well trained academically. Somewhere in this chain exists a link which is related to the philosophy of the experimenter and administrator regarding the terms and use of service and support. Often this philosophy places a rather low value on the people in service functions, hence upon the function itself. Towards the end of this chain we find a few links composed of these people who are unrecognized, lowly paid, often poorly trained and guided, often illiterate, hence nearly always poorly motivated. Yet these men and the systems they operate actually produce the crops which provide the data for ultimate "most modern" analysis.

It is very difficult to see how even the best educated and most admirably prepared individual could conduct the type and quality of research that should be expected of him unless he is given and learns how to utilize field support that is adequately responsive to his needs and that is geared to the same relative level of advancement or modernity at which he expects to

* - Member of the Rockefeller Foundation, Indian Agricultural Program, Department of Farm Operations and Management, IARI, New Delhi-12

operate. The term "relative level of advancement or modernity" is used for a reason. It must be recognized that some research efforts in the developing countries are not yet ready, nor are they yet required, nor should they be expected to attain full equality with certain of the most sophisticated efforts of the more developed countries. On the other hand, some programs in the developing countries have attained, or are ready to attain this equality. Many other programs are held back now only by lack of proper field support. The field support function must therefore be realistically and individually tailored to fit the necessary and attainable goals of each varying experiment station.

It is the purpose of this paper to explore the whole field support structure and function of the experiment station, to attempt to focus attention on some of the reasons for the disparity of expertise between the research worker and the field support offered him (or understood and accepted by him), and to present some solutions that may assist in alleviating some of the existing problems. It is the belief of the author that a clear understanding of some of the problems, alone, will be useful to all concerned with the experiment station.

2.1 SOME EXPERIMENT STATION FUNCTIONAL PROBLEMS COMMON THROUGHOUT THE WORLD

It must be stated and understood at the very outset that the proper and full field support function on an agricultural experiment station, anywhere in the world, is a very complicated and difficult task. While this task might appear to the layman as predominantly one of "farming", it is truly quite different from the common concept of farming. The following complicating differences can be observed.

2.1.1 CROPPING PATTERNS

When one thinks of a farm one normally visualizes the production of a single crop or at most only a limited number of crops in a given season. This implies a limited series of requirements such as machinery, cultural practices or special skills. One the other hand an experiment station may contain the full gamut of crops that grow in an area in a given season, with correspondingly enlarged series of requirements of machinery, equipment, practices, and skills. If a farmer is involved in a multi-cropping system it is in his own individual interest to expedite the harvest of crop "A" in order to be ready for a timely planting of a following crop "B". If he fails to do this he is the immediate loser. However, on an experiment station it is normal for crops A and B to be the projects of two different people, sometimes not even known to one another. The experimenter working with crop A is not himself greatly concerned about the time of planting of crop B. Should experimenter A exert himself at harvest time for the benefit of experimenter B? Often he does not. Only decisive action by a neutral third party, the top leadership of an experiment station, can protect the interest of experimenter B in this common problem area.

2.1.2 OPERATIONAL DECISION MAKING

In the common concept of farming one visualizes a single owner or operator who can make unilateral and timely operational decisions, with little or no thought of other owners. On an experiment station, however, there may be a whole host of "owners" (each experimenter and his project must be considered a separate "ownership"), each one necessarily making his own critical decisions that must then be carried out by the supporting agency. But think now of the complications that can (and usually do) arise on the experiment station in even such a simple matter as preparing for and planting a crop for this host of owners. Each crop --wheat is a good an example as any -- has a prime date for planting in any given area. The individual farmer recognizes this date, and if he knows he has an acreage -equipment- manpower complex that requires two weeks for completion of this operation he will attempt to start planting one week ahead of the prime date so as to finish one week behind this date. He recognizes that he must either make a compromise with time or possess sufficient manpower and equipment to do it all on the <u>one</u> prime date.

However, experience in such widely separated agricultural research communities as the U.S.A. and India, leads to the conclusion that within this host of planters of this same crop there will be many who insist their plot must be planted on that one date! No experiment station, anywhere in the world, using governmental or public funds, can afford this quantity of equipment and manpower. The concept applies to irrigation water supply and system capabilities, as well as many other common-use facilities. So the experiment station as a whole must also make a compromise with time. Thoughtful readers of this paper will immediately recognize the complications that arise in this case.

2.1.3 SIZE OF UNIT

The question of size of the farm is another important difference, particularly when considering modernized, mechanized operations. With mechanization, the bigger the fields the better from the standpoint of machine efficiency. However, the individual farm on an experiment station (again the research plot) is often quite small. Mechanized operations can become very difficult, highly inefficient, over costly, and over damaging to the farm itself unless extremely careful planning is exercized and great care is taken to minimize these problems. In many cases mechanization may prove of limited or even no value.

2.1.4 OPERATIONAL METHODS

The normal farm is operated for production, hence profit to the farmer, usually with methods that have been tried, accepted and understood. The experiment station's "farms" are operated for an entirely different reason, and often must diverge from the comfortable, understandable techniques and advance into unknown methods and practices.

2.1.5 PRECISION REQUIREMENTS

The normal farming venture, conducted for profit, can and does weigh the cost of the precision of operations against overall production gains. Precision of operation is not demanded if the excess costs of such precision are not compensated by extra production. Good research on an experiment station demands precision of operations regardless of costs. Without precise control, the total field research effort can easily become entirely meaningless. Precision of operation of course demands highly skilled, well trained personnel (well paid technicians, one might say).

Along with higher demands for precision on the experiment station, there is the added demand for total continuous reliability of all operating systems. On the normal farm, some small deficiencies such as minor equipment breakdowns or a minor shortage of water would probably lead to a corresponding minor loss of production (hence income) from areas affected by these deficiencies. On the research farm, however, any such slights could mean a total loss to the individual experimenter working in the affected area.

Regardless of the exacting nature of the job, good field support to the experimenter is the accepted rule in the more developed countries of the world. This is not the general case in the developing countries. Nearly everyone involved in field research in the developing countries realizes that something is amiss, especially if they have observed similar work in the more developed countries. Some of those involved will immediately recognize that the "capability and understanding gap" between experimenter and his field support is a major factor in this unhealthy situation.

3.1 SOME REASONS FOR THE "CAPABILITY" GAP

It is not sufficient to merely state that a restricting gap exists between the potential capabilities of the experimenter and the field support facilities provided to him. To attain the desired results of more productive research efforts, something must be done to narrow and ultimately close this gap. Perhaps the recognition of some very obvious, and some not so obvious reasons for this disparity would be helpful in rectifying the problem.

3.1.1 LEVELS AND TYPES OF TRAINING OF PEOPLE DIRECTLY INVOLVED IN FIELD RESEARCH

3.1.1.1 The Scientist

Reference has already been made to the level of academic training of research scientists in the developing areas. The need for this academic preparation is now well recognized by the leadership and administrators throughout the developing countries, and many nations have gone to great expense to provide it in one way or another. (It should be noted here that few of these research scientists have any meaningful type of practical agricultural background experience, much less in techniques of modern agriculture. The significance of this observation will appear later).

3.1.1.2 The Field Worker

Now, what about a similar set of specialized training opportunities for the technician who provide the field support to this scientist? Surely, the equipment operator, the mechanic, the irrigator who is entrusted with the actual working of an important research problem should be classed as a technician. Training opportunities specifically designed to prepare men for these types of jobs do not exist. In the more developed countries it is easy to draw the best of men into the work force of an experiment station because of good pay scales, good working conditions, etc.; they are usually selected as the choice few from a vast pool of well trained men. Such men do not exist in the developing countries where the demands of modern agriculture and the far more stringent demands of modern research agriculture are just now being encountered. Nor is it easy to train them in a short time.

In this regard it should be remembered that a large percentage of those who become research scientists in the more developed countries are themselves quite skilled in the more practical aspects of modern agriculture. They are often capable of performing, quite expertly, all the tasks carried out by the supporting agency. They recognize no loss of status in this accomplishment. In fact, they are usually quite proud of it. They are thus able to assist in training support technicians, or at least they know if a particular job is being done correctly or incorrectly. In the developing countries, however, due to the lack of relevant agricultural background, or even assuming an agricultural background under other than modern conditions, the research scientist rarely possesses these skills or abilities.

Such practical skills achieved by the research scientist-teacher in the developed areas probably serve to the detriment of the student scientist or the visiting scientist in a secondary, more subtle way. For example, a teacher in the developed countries rarely encounters any serious problems with field support. If he does he can normally solve these problems himself, because of his own background experience. This teacher often does not understand that his "foreign student" knows nothing of these more practical things, or he considers them insignificant because they are only minor irritations to him. He fails to understand that these problems can become overwhelming to the "foreign student" upon return to his home country, so he does little towards preparing the student for the practical field requirements of agricultural research.

3.1.2 LEVEL OF UNDERSTANDING AMONG ADMINISTRATORS AT HIGHER ECHELONS

As observed earlier, higher level administrators within many of the developing countries have accepted the need for financing the academic preparation and advancement of the research scientist. These scientists are a "new breed", and, being outstanding as such, arouse and encourage a new set of concepts in the minds of the administrators. Also, many administrators seem amenable to the acquisition of items of equipment such as tractors, machinery, and vehicles. (These items of hardware are also glamour items, the possession of which might lead the misinformed to the conclusion that "mechanization has been ac - complished". Actually, however, the acquisition of machinery is but the first and usually by far the simplest step of many steps on the path towards mechanization !).

To arouse the same new concepts in the mind of the administrator concerning the key roll and the importance of the overall field support structure its staff, and its operational requirements is more difficult. The persons involved, the types of jobs done, the very terms "support" or "service" lack the glamour or appeal that surrounds the title "research scientist", or the possession of a new tractor. In cases, no doubt, social stratification based upon the type of work one does hinders proper recognition of the importance of support, both regarding the people involved, the systems needed, or the methods used. This lack of recognition of the full importance of the service fuction is by no means confined to the area of agricultural research or the people associated with it. Indeed laggard service and support is apparent wherever and whenever rapidly modernizing innovation is observed, be it in industry, public utilities, transportation, etc.

Along with understanding the problem, there is the sheer magnitude of change imposed on the administrator and upon his established administrative methods and system by these totally new and different physcal and personnel requirements. For instance, under previous systems of animal powered agriculture, no mechanics, welders or electricians were required. These people become necessary immediately upon a changeover to mechanization. An animal offered inferior fuel (fodder) may refuse to consume it, or may consume it sparingly, or may eat it all and merely develop less output. Fuel systems for animal agriculture may vary quite widely without instantaneous, dramatic results. When a tractor is offered inferior fuel it exercises no right of choice. It ingests whatever is offered, but,if the offering was inferior, we do get instantaneous, dramatic results in the way of total stoppage. This stoppage, along with lost production time of the machine is usually accompanied by high and possibly unanticipated repair cost. Hence the change from animal to tractor requires a whole series of changes in equipment, in methodology, in concept, and in administrative reaction time.

Administrative systems are often slow to react to immediate, new, and different needs -- even if the key administrator is convinced of these needs.

4.1 CLOSING THE GAP

There are ways to close this capability gap and improve the research potential of the agricultural sciences in the developing countries, but they are neither quick nor easy.

As with most problems, solutions are to be found only after a complete understanding of the problem itself. Solutions to the problem discussed here lie primarily in the education or training of three groups of people.

4.1.1 THE ADMINISTRATOR

It must be the goal of administrators to improve the agricultural research capability of their country. To do so they must learn of and identify more of modern needs for modern research programs. They must modernize administrative procedures and practices to keep pace with the ever-accelerating rate of advance of modern research. This will require a complete and intimate knowledge of the methods, means, and goals of research programs under their administrative control. Administrators must come to recognize the entirely new type of highly skilled man power required to support modern research. They must recognize that these new skills and greater responsibilities will demand better educated, more progressive men who can adapt to modernization and who in turn, deserve higher pay, improved working conditions, and increased recognition.

4.1.2 THE SCIENTIST

The research scientist should be required to receive -- as an important, formal part of his preparatory training -- far more exposure to actual field activities. Courses of "farm practice" involving physical field work should be included in the academis curriculum. Only by actual physical performance of a task does a person truly understand it. This cannot be accomplished in a lecture hall. Until one truly understands a task he is unqualified to guide others in its performance. If a scientist is unqualified to guide certain of the more critical activities involved in his work, and leaves these entirely to "someone else" who may also be less than adequately qualified, disappointments are bound to occur.

More practical field training and experience will thus enable the scientist to better guide his work and to produce better research. It will also make him more cognizant the capabilities and limitations of supporting systems and personnel. This will react not only to his own personal advantage, but also to the advantage of all on a given station.

4.1.3 THE SERVICE PERSONNEL

As stated previously, modern research methodology requires highly skilled technologists both in leadership and in the more mundane duties. The skills required are new. They are not part of an old tradition. In fact these skills are total departures from the older, traditional ways of doing things. Therefore training and more training must be given to people who can absorb it and who are capable of adapting to the new methods. Only better pay scales, working conditions, and levels of recognition, mentioned earlier, will tend to attract the proper people. Special schools for the practical training of these technicians must be established. People thus trained will find ample employment opportunity in commercial agriculture as well as research agriculture. On-the-job training is a continuous procedure, of course, and must remain as an important source for manpower development. However, during his apprenticeship period, the trainee is often of only limited value.

Though the picture of field support to agricultural research is generally a discouraging one throughout many of the developing countries, brighter spots do appear.

As a single example, and there are certainly others the Indian Agricultural Research Institute, New Delhi, India, is presently fostering a substantial effort to close the "capability" gap. A limited amount of improvement has been achieved in modernization of fiel research facilities, in the upward reclassification of some of the field staff, and in on-the-job training of operational personnel.

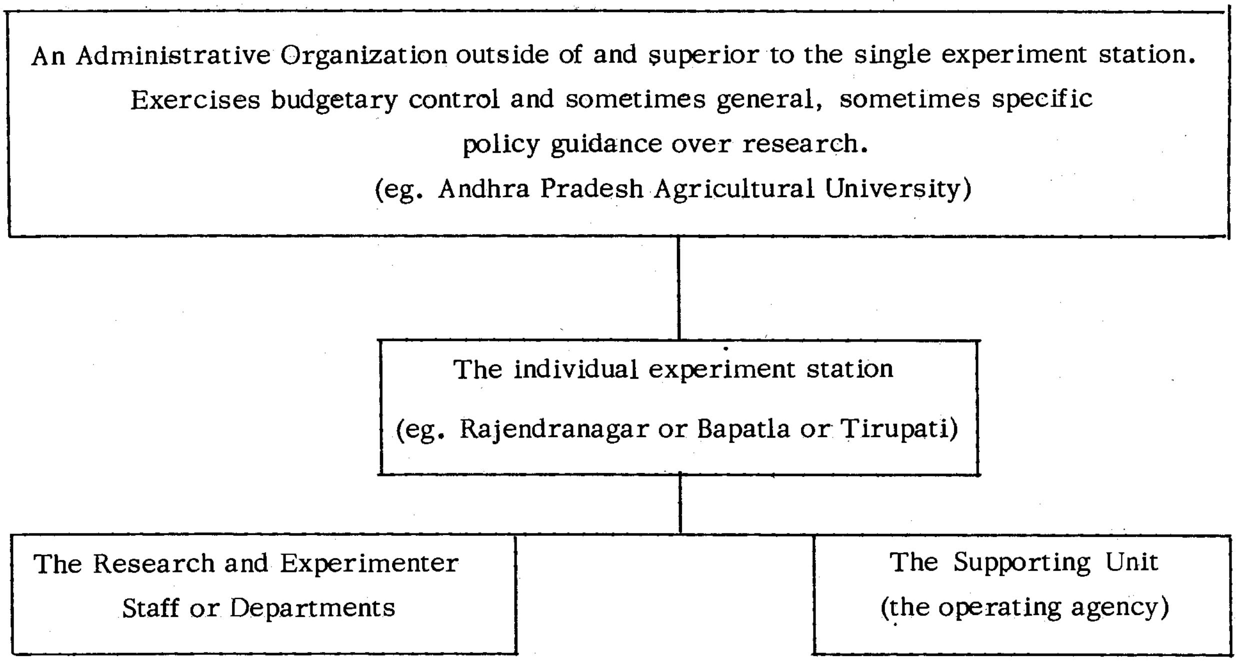
There is every indication of an increasing awareness of the modern needs for modern research programs on the part of administrators, scientists, and service personnel

5.1 THE FIELD SUPPORT STRUCTURE AND FUNCTION

5.1.1 THE STRUCTURE

As has been pointed out earlier there are several different levels or groups of people that are directly involved as integral parts of the whole field support structure. These relationships might be portrayed schematically as follows:

RELATIONSHIPS IN FIELD SUPPORT STRUCTURE



5.1.2 THE MISSION

Stated broadly, the mission of field support is to provide the best possible physical environment and systems for field experimentation and to relieve the experimenter of routine operations so that he can devote his full time to research. More specifically this could involve development and maintenance of irrigation and drainage systems where required, preparation, cultural care and assistance in planting and harvesting of experimental plots, the provision, operation, and maintenance of farm machinery and equipment, and the accomplishment of any other service duties as might be prescribed by proper authority.

5.1.3 THE OPERATING AGENCY

The size and composition of the support unit will of course be dictated by the mission to be accomplished, so will vary from situation to situation. Several factors governing this will be:

a. The size, composition, and complexity of work of the supported station.

b. The degree of mechanization.

c. The complexity and intensity of cropping.

d. The special requirements such as irrigation, drainage, and land development.

5.1.4 OPERATIONAL POLICIES AND PROCEDURES AND ORGANIZATIONAL REQUIREMENTS

These less tangible elements of the field support structure are probably of far greater importance than the machines or other visible systems in the conduct of the support operation.

It must be kept in mind that the support unit exists only to serve the needs of the research staff. This would be no problem if there were always sufficient facilities such as land, machinery, manpower, water, etc. to satisfy all demands at the same time. However, there are almost never enough of these facilities to satisfy all demands - at the same instant- especially in the case of a large progressive staff on a multidisciplined station. Conflicts of interest between experimenters, or between experimenters and the station, will certainly arise and will require judgements and decisions that should not be the responsibility of the service unit should be prescribed by a senior control office.

5.1.4.1 A Senior Control Office

This office could be the Director of the Station, a Director of Research or a Farm Research Committee acting in the overall interest of the Station. This would normally be the same office that would review all research proposals for each season and make appropriate assignments of experimental areas to academic departments or to individual projects as the case might be. The service unit should always remain strictly the action agency for carrying out the general policy and specific instructions of the senior office. In addition to its knowledge of the research objectives of the station, this senior office must be fully and constantly aware of the capabilities and limitations of the support unit and its associated facilities. This awareness can come only through constant and close association between the two offices. Certainly no major shifts in activity that would impose new and different demands on the support unit or systems should ever be seriously considered prior to the two party determination that such new demands could be supported. If the senior control office fails to do this and assigns unrealistic tasks, or unattainable goals, overloading could occur which could imperil the whole support structure. As a particular girder or beam in a building is predesigned to carry a certain load, so is a support unit or facility of an experiment station. If the beam is overloaded, it will fail, possibly destroying the building. So it is with the support unit and its facilities.

5.1.4.2 Organizational Options at the Station Level

The station level organization of the field support function can take on a variety of forms. Any of these could be successful under particular circumstances. Three general options, in order of the author's preference are:

a. The all-farm unit with all common use facilities centrally operated and controlled. The unit operates under the control of an through the policies established by the senior control office. This method allows maximum exploitation and economy of manpower, equipment and money. It presupposes that many of the common usage items required to service the combined needs of a modern station -- for example, the fueling equipment, welding equipment, a battery charger, or a high capacity air compressor -- need only be provided at a single location. This method places the highest demands on the leadership and personnel of the support unit. It also places the highest demands on the senior leadership and individual experimenters of the station. Sound operational procedure and policies must be established to insure impartial service to all participating experimenters. This method does not imply centralized control over special-use items of equipment that would remain strictly under control of individual departments, even though maintenance of such items might well be a centralized function.

b. The all-farm unit, appended to and controlled by one of the academic departments (usually agronomy or engineering). Theoretically this method has all the advantages of the first method suggested. However, in practice, quite often the service function comes to be a competing burden to the teaching and research responsibilities of an academic department. When this happens, the service function suffers first. Also, in this option there is always a strong possiblility that the parent department may receive a larger than proportionate share of service.

c. Fragmented facilities with each academic department of a station having its own support unit. This method has the obvious advantage of closer control over manpower and equipment usage by the departments and the individual experimenter. It has the over-ruling disadvantage of usually being far too costly in manpower and equipment. Many items and services which might easily serve a whole station must be duplicated in each of the isolated units.

5.1.4.3 Internal Organization

Regardless of the method selected for station level control of the support unit, the internal organization of the unit should provide sections for the functional requirements of administration, operation and maintenance and repair.

a. Administration Section

Personnel should be provided in this section to handle all administrative matters for the support unit. These will include muster rolls, payroll, leaves and other absences, budgets, property accounting, stores, etc.

b. Operations Section

This section should be staffed with personnel for control of farming operations including irrigation and drainage, and for operation of all farm machinery and equipment. Records of all pertinent operations and plot histories should be maintained by this section.

c. Maintenance and Repair Section

This section should be staffed with personnel to control, program, and carry out maintenance and repair operations on all machinery and equipment used by the unit as well as keeping all logs and other required equipment records. A possible organization is shown in the chart on the following page.

6.1 EXPERIMENT STATION DEVELOPMENT

6.1.1 GENERAL DEVELOPMENT

It would be quite rare to find land suitable for the needs of a modern research station without requiring at least some amount of "development". Obviously these amounts, hence the costs involved, can vary widely. Certain types of experimentation are more sensitive than others insofar as developmental requirements are concerned. This is particularly true in cases where irrigation and drainage are required. Even in cases where irrigation is not practiced some land shaping may be advisable to insure more even subsurface distribution of rainfall. Developmental steps such as the provision of a network of adequate access roadways becomes more important as a station moves towards mechanization.

Senior Control Office

(This could be the Head of a Station, a Director of Research, etc.
This is the office of final authority in matters relating
to field support)

Control

Academic Dept. A

Academic Dept. B

Academic Dept. N

Coordination & Liaison

Field support unit.
The head of this unit should be on a par with heads of the Academic Departments

Administration Sect.

Clerks
Storesmen
Security personnel, etc.

Operations Sect.

Fieldmen
Equipment Oprs.
Irrigation- etc.

Maintenace and Repair Sect.

Mechanics
Auto Electricians
Welders- etc.

* - Notes:

1. The field support unit is controlled by the same office that controls the academic departments, thereby it is placed on a par with the academic depts.

2. The field support unit exists only to serve the field research requirements of the academic departments, but does so in the name of and under the final authority of the Senior Control Office. This is necessary to insure coordination of effort and equality of treatment to all academis departments.

3. The size of the support unit will be dictated by the size of the research effort it is expected to support.

Certainly development should, wherever possible, precede experimentation. To attempt to "work-around" on-going research is extremely costly and is quite frustrating to all concerned. In many cases, if properly planned, development can proceed by phases or steps with areas being turned over to experimenters when completed.

6.1.2 PLANNING FOR DEVELOPMENT

Experiment station development requires a great deal of judicious pre-planning by people who adequately understand the biological, physical, engineering and mechanical requirements of modern research. They must also be able either to realistically predict or ultimately exercise control over directions the research effort of the station will take. If this is not possible, they must be able to react quickly to provide changes in support to keep up with changes in program. Predictions of this nature are difficult to make with accuracy. Control over future direction is difficult to exercise. Rapid changes in supporting facilities are difficult to implement. But unless those responsible for development activities are given accurate guidelines they will be unable to arrive at workable and economical solutions.

On occasion, certain facets of development planning have been wrongfully blamed for inadequacy of facilities soon after completion of the facilities. This blame usually rests with inadequate top level evaluation of needs, or on rapid shifts of direction of the research effort without accompanying rapid compensating development activity to provide for new demands made on the facility. For example, during planning for irrigation facilities for a particular station a certain cropping mix was envisioned as a continuing pattern. This cropping pattern, in conjunction with climatic and soils data, formed the base for a particular set of assumptions concerning water and irrigation system requirements, regarding both supply and delivery capacity. The system, was built accordingly. Then a drastic shift in crop pattern occurred that required approximately a three-fold increase for high water demand crop (rice), with no compensating accompanying increase in the supply and delivery capability. The system was unable to adequately supply this area plus the immediately adjacent area. This was no fault of the system as built. Rather it was the result of inadequate planning at the top level, compounded by the failure to recognize and accept the built-in capabilities and limitations of the system originally designed; then further compounded by the inability to immediately react to the new and different set of demands through the immediate provision of enlarged delivery capabilities and increased water supply.

Any good development plan must provide for certain amounts of flexibility.

6.1.3 DEVELOPMENT ACTIVITIES

Experiment station development usually brings to mind the grading (shaping) of land, the layout of experimental fields, the construction of roads, the building of systems of varying sorts for irrigation and drainage and the construction of buildings for shops, equipment, and storage.

Each of these activities involves the application of its own set of simple, well known principles. But each activity must be studied simultaneously so that they all can be merged into the integrated whole unit of the station.

The grading or shaping of the land on an experiment station cannot be planned without consideration of the location of water sources, drainage outlets, or consideration of precision peculiar to good research. The generally recognized and published principles of land shaping were developed for the requirements of commercial agriculture, not for the more strict precision requirements for research agriculture. Normal grading towards the "best slope" for a given field might not fit in with some of these other, more compelling precision factors.

The layout of field units involves "before development" decisions as to dimension, slopes, and permissible physical barriers. These decisions are regulated in turn, by soil types, expected crop patterns, irrigation and drainage requirements and capabilities, and the requirements for mechanization.

A few examples of these regulating features may be useful:

a. Irrigation "length of run" on sandy type (high infiltration rate) soils would be shorter than on clay type (low infiltration rate) soils. Hence field sizes may be dependant on soil types.

b. If the station is being developed solely for crops best suited for border strip irrigation (small grains for instance) and surface drainage is not an important consideration, then fields with a single slope might be considered tha best. On the other hand if surface drainage as well as irrigation is required on this station, due to expected high intensity rainfall during a different crop season, then both a down field irrigation slope and a cross field drainage slope might be necessary. This requirement for a cross-field slope will of course impose limitations on the reasonably permissible width of an irrigation border strip. This in turn imposes physical limitations on research plot dimensions. For example, suppose a 0.2 per cent cross field slope exists in certain fields of a given station for the purpose of rapid disposal of excess rainfall. This means that irrigation water will flow 6 centimeters deep on the lower side of a 30 meter wide border while the higher side of this border strip would remain dry. The existing physical fact of slope and its effect on irrigation uniformity must be taken into consideration when plot width is considered. In this case, border strips should be limited to 6 to 7 meters width in lighter soils where relatively small quantities of water are used.

c. Physical barriers to movement, such as deep drains between fields or above ground irrigation channels or pipelines, or bunds (levees) between fields, do not seriously hinder animal powered farming systems. Animals, and their light-weight tools can often operate through, over, or around these obstructions quite easily; tractors cannot. So if a station is to be mechanized the developer must make every effort to prevent the existence of or to remove these barriers that hinder complete mobility and accessibility.

6.1.4 THE MECHANICS OF DEVELOPMENT

Nothing need be said here of the "mechanics" of development of the experiment station. Countless textbooks, bulletins, and pamphlets exist that tell how to grade land, how to build irrigation pipelines or other irrigation systems, or how to plan and build drainage systems, and how to erect buildings. These are all part of the modern literature with which experiment station developers must be familiar. It will only be re-emphasized here that the degree of sophistication and the type and quality of the research output from an experiment station can be no more advanced than the developed facilities of the station will allow. The initial choices and decisions made in the earliest phases of experiment station development planning become and often remain the factors which control or limit the future destiny of the station.

Experiment station development is only an initial, though very important, step towards the objective of good support to agricultural research. The best "developed" station in the world will rapidly revert to useless bits of land unless properly operated, as will the best built automobile in the world become a hulk of useless metal unless it is properly operated. Properly operated means operated in the manner and within the capabilities for which it was designed or developed. Since such an intimate relationship exists between station development and subsequent station operation, it is advantageous to have the developer become the operator whenever possible.

7.1 EXPERIMENT STATION OPERATION (MANAGEMENT)

Many of the major decisions which bear upon the operation and management of a station will have been made in the developing planning phase. These decisions will have to do with mechanization, field layout, irrigation system requirements and capacities, drainage requirements, probable crop patterns etc. Broad operational procedures and policies will be established by some senior controlling headquarters usually in conjunction with the research staff or at least components of the staff.

If the station is a single purpose, one crop, or a one discipline station with a limited staff, a simple uncomplicated operational procedure is satisfactory. Likewise, the absence of irrigation or drainage requirements would simplify the operation of a particular station.

Often, however, many of the more important experiment stations are multidisciplined, multi-crop, with large staffs, and a cropping intensity of 200 per cent or more. As pointed out earlier, operation of this type of station becomes a more complicated task.

It has been suggested that the "operations" portion of the field support function include maintenance of experimented areas, operation and maintenance of irrigation and drainage systems (where required), preparation, cultural care, and assistance in planting and harvesting of experimental plots, the operation and maintenance of farm machinery and equipment, and the accomplishment of other service duties as might be prescribed by proper authority.

The field experiments of the research staff provide the basic purpose for existence of the station. A whole series of operational activities must be integrated towards the accomplishment of proper support to the experiment in the field. These activities are so numerous and so varied in scope or method that they cannot be properly discussed in a paper of this sort. Whether to plow or disc-harrow a field, how to do it, and when to do it, or how to irrigate, when to irrigate, and how much water is to be applied, or when and how to cultivate a particular field, are but a few of countless operational decisions that are faced daily, plot by plot. Each of these will be governed by conditions that prevail at a particular location at a particular time.

Those who are in positions of operations leadership must be able to make these decisions, or they must carry out the instructions of an experimenter who has made these decisions himself. This implies that the experimenter is qualified to make them. One of the primary reasons for the specification by a senior control office of operational policies and procedures (referred to earlier) is to ensure the existence of mechanisms which foster the close collaboration of the experimenter and the operator in much of the operational decision making. Some of these decisions should probably remain the responsibility of the operator, some of them should be made jointly, others should remain strictly under the control of the experimenter. However, the operator must keep constantly in mind the fact that this job exists only to serve the station and its experimental plots.

The necessary and constant reminder to the experiment station operator that his job exists only to serve the plots of the station can sometimes lead to a series of totally unnecessary conflicts of interest. On the surface, these conflicts appear to be between the operator and the individual experimenter. Actually they are between the experiment station, as an operational entity, and the requirements of the experimenters.

The operator's duty is to serve all the plots of the station. He is held responsible for all the land, all the equipment, all the field facilities of the station. He serves all the experimenters both in the individual sense, and (as is often misunderstood) in the group or station sense. He must be planning ahead and coordinating the requirements for the next season's crop; for all plots, as he removes last season's crops; for all plots, to prepare for the current season's plantings of all plots.

The operator is not permitted the freedom of thinking of only one or a few plots, one season at a time. He must perform functions for all experimenters within budgetary (financial) limitations that are usually quite strict even in the most affluent of research communities. From the standpoint of economy, of both money and time, he must ensure the utmost coordination of all field activities of the station.

On the other hand, the experimenter, no matter his background, thinks, first, last, always and, sadly sometimes only of his own work in a strictly limited current sense. Commendable as this attitude may be from the standpoint of immediate individual accomplishments, it must often be tempered by concessions to the interests of the experiment station as a whole. Without this tempering of immediate self-interest to the long term station interest, an integrated, viable experiment station cannot long exist.

Rules to protect individual and group interests become more and more demanding as systems become more sophisticated and modernized, as research programs become more refined and exacting, or as research areas and facilities become more crowded with more keen competition for space and time. These costs, the acceptance of rules and the imposition of restraints upon the individual, are the costs that must be met if modern calibre research is to be achieved in a group situation under modern conditions. The choice to accept or reject these costs rests with the leadership and staff of each experiment station.

A reasonable analogy might be drawn here from the differences between older and more modern means of transportation. The more primitive means of transportation required no traffic laws or traffic police men. No formalized rules to protect the individual or the group were necessary. Self-discipline demanded by society from the individual was minimal. Persons walking about with loads on their backs probably rarely interfered with each other physically. Observe, even today, in places where animal drawn conveyances are still in use that collisions between these are practically unknown. The power source involved possesses the intelligence to prevent collision even thoug the driver may be sound asleep, and further, if such a collision were to occur the consequences are of but a minor nature because of the slow speeds involved.

Change the scene now to a modernized system with highly refined means of high speed movement and more crowded conditions. Traffic laws, traffic policemen, formalized rules of the road, and most important of all, strict self-discipline on the part of the driver, have all become extremely important, both to the functioning of the system and to individual and group survival. When collisions occur today the consequences are often not of a minor nature. It is a sad truth that most of such collisions (conflicts of interest!) are caused by some individual who violates the rules established for the group interest for his own momentary self-interest.

Careful operational planning in advance by both operator and experimenter, and adherence to plans agreed upon will reduce conflicts between the interests of the station and the individual experimenter to the minimum. Any remaining must be settled by judgements from the top leadership of the station, not by the station operator.

8.1 EXAMPLES OF COMMON PROBLEM AREAS AND SOLUTIONS

8.1.1 CRITICAL TIME PERIODS

Reference was made earlier to the necessary compromise with time around a "prime" planting date. The same considerations apply to harvest dates, certain inter-cultural operations, and to some extent irrigation. As stated, it is not financially realistic, hence it is not in the best interest of the station to possess sufficient manpower, machinery, or irrigation facilities to service all the fields of a particularly large acreage crop on the same day.

However, this problem can be minimized by carefully planned schedules of operations, accomplished between operator and experimenter, to ensure maximum effective use of all manpower and facilities during such critical periods. At the working level, this means the following:

a. The operator must anticipate these critical periods and ensure that all facilities required are ready, well ahead of time.

b. The operator,again in anticipation of such critical periods, must ensure that none of his key personnel are absent during these times.

c. Administrators must recognize that such time periods will exist and must authorize extraordinary expenditure for temporary manpower or "overtime" work if required.

d. Experimenters must be ready to proceed with plantings or harvests according to pre-arranged schedules. Equipment and manpower must not be kept idle waiting for Experimenter "A" when Experimenter "B" could be using it.

8.1.2 LAND PREPARATION AND LAND USAGE

Another common problem area that presents itself has to do with field preparation and land usage in a tillage, or tillage-irrigation unit that is to be occupied by several different experimenters. This is particularly troublesome during the transitional phase where traditional animal powered tillage is giving way to mechanized tillage methods. Traditionally, animal powered farming is associated with relatively small fields. However, as operations become mechanized, as more horsepower becomes available to pull larger and more effective tools, and as more sophisticated research techniques require more carefully maintained irrigation and/or drainage slopes, relatively larger fields become necessary. Tractors become extremely inefficient, operational costs both in time and money become excessive and considerable damage can be caused to the land itself as tillage units decrease in size.

Consider, as an example of this problem, a 2.5 ha. unit containing five 0.5 ha. experiments. Further suppose that each of these experiments is grown during a different time span. This would mean 5 separate trips to this field for each cultural operation. It would mean 5 x 4 "edges" per field, or 20 turn arounds with the ever ensuing soil compaction at turn zones as well as disruption of field slopes at the turn zones.

The excessive number of trips to the field, the wasteful expenditure of funds on turn around time, the unnecessary machinery wear, the damage to future use of the field caused by compaction and the disturbance of levels leading to surface drainage problems are certainly not in the best interest of the station.

Careful and realistic planning on an all-station basis can solve nearly all problems of this sort. The grouping of crops of similar seasons and with similar agronomic requirements into the same tillage unit will allow initial land preparation to be accomplished on a larger field which can then be subdivided into as many experimental plots as desired. It is recognized that plots with isolation requirements do not fit into this pattern.

From the stand point of benefit to the interest of the station this would mean, in the example at hand:

a. Only 20 per cent of the cost in time and money for travel to and from the field. (e.g. only one trip to the field for plowing rather than 5 trips).

b. Only 20 percent of the cost in turn arounds at field edges (e.g. only 4 edges rather than 20).

c. Reduction of within-field compaction zones in the same ratio, and

d. Reduction of disruption of field grades in the same ratio.

The above benefits certainly would seem to justify the establishment of rules for their accomplishment.

9.1 SUMMARY AND CONCLUSIONS

In recent years, substantial advances have been made in agricultural production in the developing countries. These advances are largely the results of agricultural research-some conducted within these countries, some imported from the developed areas.

If these advances are to be sustained and are to keep up with new and ever increasing demands of today and the future, more and better research will be required within each of the developing countries.

Any finished product can be only as good as the ingredients which go together to form it. Agricultural research can advance no further or faster than allowed by this all pervasive, ever present, common foundation of field support.