MANAGEMENT AND DEVELOPMENT OF AN AGRICULTURAL RESEARCH INSTITUTION

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INTRODUCTION

In recent years, an increasing awareness of the problems related to development and management of agricultural research and its importance has become apparent. The spiralling of research costs and the need to develop agricultural research systems in developing countries have lent a special urgency to finding the optimum form.

It is the objective of this paper to present some ideas to help in understanding the problems of developing and managing a national agricultural research program that has its own specific characteristics and therefore sometimes requires unique adaptations of basic management principles.

MANAGING STAFF

Institutional Model

Managing the staff is managing the institution. The various ideas developed and presented in this paper are related to an institutional model based on the following assumptions as far as the research institution and its environment is concerned.

1. **National Research Responsibility** — The institution has an over-all responsibility for agricultural research at the national level.

2. **Responsibility Limited to Research** — This responsibility is limited to

research only and excludes both extension and education.

3. **Problem-Oriented Research** – The institution is dedicated mainly to applied research aimed at solving farmers' problems. Organization and classification of knowledge and development of theory do not constitute major functions.

4. **Federal-State Cooperation** – The political setting is a federal system in which importance is attached to the cooperative aspects of joint efforts between federal and state systems to put agriculture on a scientific basis.

5. **Political Importance of Agricultural Research** – The social environment favors development of science, due to the following forces:

   a) The realization that science is an important source of national power;

   b) An urban population dominating the political process and putting pressure on goverment to find solutions to rising food prices, with the latter realizing that the only solution is in supporting agricultural research institutions;

   c) Producers being forced by rapidly rising production costs to give additional support to agricultural research;

   Depending on the political organization, the national aspiration level, and the levels of industrialization and urbanization, one of these three forces will predominate. The research administrator should be able to predict correctly where the potential demand for research will be, so as to be able to adjust the development of the institutional system accordingly.

6. **Increasing Research Output** – The institution has two major outputs: research results and well-trained research workers. It is the function of the administrator to make decisions which guarantee and facilitate the increasing flow of these two outputs. The first of these, research results, is essential to obtaining the increasing support of society. The second, well-trained research workers, is proof that the institution is continuously improving its capacity to produce research results, therefore becoming increasingly more useful to the society it is a part of.

7. **Performance Motivation System** – The institution is organized so as to create a climate that stimulates creativity, recognizes talent and encourages the members to make farm problem-solving the major form of professional

satisfaction. An attempt should be made to single out factors which facilitate institutional development so as to create standards to guide short-term decision making.

Organizational Factors

A research institution is projected to have a rather long life span. Many people confuse this with the idea that research institutions need a long time span to obtain valuable results. In reality, every research institution produces some results every year. A research institution is like a dam that takes years to be built; once built, it provides a steady supply of energy. This confusion has resulted in agricultural policy makers not giving sufficient importance to research,because they want short-term results.

The long life of a research institution creates special needs for a continuous renovation process to avoid becoming obsolete. To avoid obsolescence, research institutions should be allowed the following:

1. **Financial and Operational Autonomy** – A legal organization that permits freedom in capturing financial resources, management of its budget, a personnel policy appropriate for a research institution, and a close relationship with the university system, the private sector and foreign research institutions. It must also have freedom to formulate its own research program.

2. **Joint State-Federal Support** – It is essential to appropriately divide the responsibilities between the federal and the state governments. Depending on the stage of political development of the country, a major responsibility can rest with the federal government as long as there are mechanisms that assure continuous decentralization in favor of the state or regional governing bodies. One must not forget that research is always site specific, making it difficult for the federal government to be responsible for solution of the problems that are specific to certain states or regions. On the other hand, the local political power will not fully support research programs and institutions without being directly involved in their administration and financing.

3. **Location and Size** – The research station should be located in a region that either commercially produces the commodities of interest or has resources required by the research. This will assure that research workers will be in continuous contact with producers. These contacts will inspire

research workers to concentrate their efforts on relevant problems and encourage them to continuously strive for professional achievement based on solving farmers' problems. The research units should specialize in a rather limited number of products or problems to avoid diffusion and dispersion of effort ,and keep their size to a controllable number of researchers estimated at between 30 and 100.

4. **Problem Solving**– The traditional organization of research institutions is in the form of specialized departments set up by disciplines. The main function of these departments is to gather a group of scientists, create pressure on the budgeting process so as to benefit the discipline and allow scientific development and growth of a given field of specialization. This organization may create difficulties for problem-solving research aimed at producers and demanding formation of interdisciplinary groups. These difficulties can be solved with a certain ability and patience,so as not to compromise the professional interests involved. On the positive side, this organization has the advantage of being able to prevent the research institutions from dedicating themselves exclusively to the solution of short-term problems that, as experience has shown, do not produce the highest returns in the long run.

The other form of organization is to create multidisciplinary teams for solution of specific production oriented problems. This organization guarantees a better performance in terms of the solution of given problems, and facilitates collaboration among,and administration of research workers. It is also more responsive and relevant ,as far as farm interests are concerned. Still, it may have the disadvantage of reducing creativity of scientists who have different interests than those of the dominant group, and may result in superficial research work if certain precautions are not taken. The organization tends to benefit from group action to the detriment of individual actions that are necessary to obtain the research results. It is, however, an appropriate model for applied research ,as long as the individual work of each scientist is protected. The definition of the problem is made by the whole group. After that,each member formulates his own project.

Frequent meetings should be held for the purpose of following the development of the projects, avoiding major deviations from established objectives, making proper changes when needed and evaluating the results. Here, the most important factor is the capability of the team leader.

It is possible to combine the two forms of organization, i.e., the traditional disciplinary departmental organization with the multidisciplinary team organization. The departments will be restricted to basic disciplines or to the service areas such as: laboratories, administration and others.

5. **Maximizing Time Devoted to Research** — The resources allocated to research are usually limited. As a result, programming aimed at optimum efficiency becomes very important. Still, experience shows that a strong programming-planning system of research has a high cost, in practice. A rigidly programmed research institution does not attract private initiative or participation of university systems. It does not follow basic procedures of scientific methodology, but tends to be general rather than specific and over-demanding in terms of time dedicated to paper work by individual research workers, who constitute the most valuable resource of any research institution. It tends to be more bureaucratic and centralized, is an excellent producer of "reports", but inhibits good ideas. Thus, all programming functions should be permanently subject to critique by research workers, so they can be adapted and improved continuously for the convenience of the research workers concerned. In other words, the programming system must be as dynamic as possible.

6. **Short-Term vs. Long-Term Projects** — There can be a conflict between the short-term interest of farmers (or of local governments) and the long-term future interest of the nation. In other words, short term political objectives may clash with long-term scientific considerations. To avoid these potential conflicts, the research program must be well balanced in terms of short--term and long-term projects. Giving needed priority to producing immediate results, that are easily adopted by farmers, is indispensable for survival and growth of the institution. At the same time, the projects of greater impact or productivity, that need longer time for execution, cannot be sacrificed. The program must also include those projects which have high risk since these give much higher returns once successful. The program should take into consideration actual production practices of various farmer groups, the interest and potential of small and low income producers, export crops and other special interests. Finally, it is very important to avoid dispersion of efforts, through establishment of a set of research priorities.

7. **Financial Stability** — The nature of research activities requires a reasonably

steady budget and cannot tolerate wide fluctuations in financial resources. However, in practive, the budget should not provide excessive financial security to all scientists in terms of research money. At least a part of the resources should be given in a competitive process in which research workers submit projects for financing by private institutions or foundations and try to finance part of their on-going work through the selling of produced technology and patent rights. This search for financial resources, even though time consuming and sometimes frustrating has the advantage of creating permanent interest on behalf of the institution in the problems of society and in developing the ability to relate and communicate with the existing political and economic power structure that otherwise would be neglected. Commercial production, using idle resources and newly developed technology produced by experiment stations constitutes an excellent opportunity to test certain innovations before their diffusion among producers. Commercial activity of research units should not interfere with the major function of research and its administrative set-up, and if possible should be separated.

8. **Authority and Decision Process** – The institution of applied research, oriented towards obtaining short-term results based on quick decisions, has a tendency to be vertically structured,with a strong hierarchy,instead of being a democratic and participatory organization as in some,more traditional research institutions. A vertical power structure in regional experiment stations is not necessarily antidemocratic. Still, it does have the potential of being a totalitarian system that may stagnate the institution. Various alternatives have been tried to solve this problem. One, is an elective process for choosing executive personnel. This results in the leadership becoming overcommitted to the private interests of their electorate. In terms of the general objective of the system, this is not always productive. Another alternative is to create working groups and committees of research workers that sometimes include producers and consumers who participate in administration,or at least in setting up the general policy of the research institution. The optimum solution should be worked out for every case. The major consideration is to find an equilibrium between lack of flexibility of a vertical structure and the need for fast decision making, not common to any decentralized democratic organization. Decentralization of power could be achieved through giving certain autonomy to decentralized units without destroying the over-all power structure of the institution. Local autonomy, even though healthy from an organizational point of view, may not give a needed voice to research workers,and thus has to be complemented by other systems that

give direct representation to research workers, to producers, to consumers and to extension personnel.

9. **Outside Contacts** – The relationship with the outside world could be given only limited space in this paper, mentioning only the following items which are considered of major importance:

   a) **Producers and Private Enterprises** – It is vital to assure an intensive and direct relationship with rural producers and private enterprise involved in the agricultural sector. This relationship promotes the interest of research workers in relevant problems and creates an interest in research on the part of various groups that have power to influence in the allocation of needed public and private resources for research. To see and to hear, are two different things. The researcher has to see in order to understand. He will not understand, very well, a problem seen and reported by others. Certain details, sometimes crucial, escape the observation of a non-trained person.

   b) **Extension Service** – The process of creating knowledge is a continuum that starts with identification of a problem, and terminates only when the producer, incorporates into his production system, the technology resulting from the research aimed at the solution of his problem. There are various functions during this process. It is common to differentiate two of them: research and extension. The first creates a body of knowledge, while the second adds to the research results the information needed to make them adaptable by producers. "The former creates the product, the latter sells it". These two functions can be located in the same institution or can be separated. In both cases, the problems of integration are present, due to the fact that the work of researchers and extension workers do not coincide, even though they may have the same objective, i.e., to increase the productivity of agriculture and the well-being of producers. The integration between extension and research lies, in the first place, in showing that the interests of the two groups coincide, and that one cannot survive without the other. Secondly, a way must be found by which each group participates actively in the work of the other, both at the producer contact level and in the initial or continuous training programs. Finally, it should be recognized that a certain amount of competition, and even professional jealousy, is healthy and productive in spite of what many people think.

   c) **Mass Media** – A good relationship with the mass media is indispensable

for communication between research workers, consumers, government and the private sector. The mass media coverage should be aimed at local and national levels. It should be handled in a professional way, using specially trained personnel. To build up a good public image and favorable public opinion is a task that requires a major effort and cannot be neglected.

d) **Institutions of Higher Learning** – University systems have high-level trained personnel. The areas of potential collaboration are the following:

- **Education:** Both short and long-term training of agricultural research technicians at the advanced degree level, and in specialized non-degree courses;

- **Consulting:** Providing technical services related to special problems identified by research;

- **Exchange of Personnel:** University personnel working in research institutions, occupying administrative and executive positions, when needed, and vice-versa;

- **M.S. & Ph. D. Dissertations:** Use of graduate students to prepare dissertations dealing with problems identified by research;

e) **International Contacts** – Agricultural technology is site specific. Rarely can it be transferred from advanced countries without a major adaptive effort. Still there are great benefits in contacts with other countries and international organizations.

The major areas are as follows:

- The science and scientific methodologies that generate technology have universal application. Advanced training of technicians at universities and other institutions and use of foreign specialists for short or long-term assignments helps in omitting some,or accelerating other institutional development stages, leading young research workers to the frontier of knowledge faster.

- As a product of many years of work, advanced countries have been able to gather and develop germplasm collections and a genetic basis for plants and animals, aimed at increased productivity. These

collections have a great potential to contribute to plant and animal breeding programs in any part of the world.

INSTITUTIONAL DEVELOPMENT

There is no substitute for the quality of human resources in research. This is why the principal task of administration is to help to create an institution that stimulates high-level performance based on creativity and that protects talents. The first part of this paper dealt with the management aspects of research institutions. The second part will treat various aspects directly related to institutional development.

Development of Human Capital

The formation of human resources represents institutional investment in human capital. The following principles should be recognized in developing human capital:

1. **Avoiding Potential Depreciation** – One cannot forget that human capital has depreciation rates that can be very high in an environment that does not stimulate a continuous search for knowledge,or that is unhealthy or that creates irritating internal frictions and alienation of individual technicians within the institution.

   To avoid depreciation of human capital,the administrator should try to offer incentives to individual research workers through continuous investment of time and money in their education. This is necessary due to the fact that the capacity of each research unit to achieve given objectives is, to a major extent, a function of the quality of the technical staff rather than their number.

   Certain factors still exist in research institutions that induce a high level of human capital depreciation. The leading contributors to this process are: lack of wage differentials among those who produce and those who do not; lack of healthy professional competition; small number of research workers with advanced training; extensive bureaucracy; shortage of support personnel able to increase the efficiency and output of individual researchers; lack of tradition in terms of administrative

research leadership. This type of institutional setting puts a heavy risk on investment made in human resource development.

2. **Lack of Equlibrium Between Actual and Potential Knowledge** – It is important to emphasize that depreciation of human capital has two dimensions: one absolute, the other relative. The absolute level refers to the loss of knowledge due to time and lack of usage. The relative dimension refers to not keeping abreast in relation to progress made in scientific fields that are developing at a very fast rate. In this case, the research scientist, instead of trying to diminish the distance between his knowledge and the frontier of his field of science, lets this gap grow and is left further benind every day. (See Fig. 1).

   The effort to learn more is made as a response to the lack of equilibrium between what one knows and what one could learn. Conditions that allow for the perception of this continuing lack of equilibrium, and that tend to perpetuate it, should be maintained. This situation motivates a desire among research workers to continuously increase and widen their knowledge. Differential salary scales, following post-graduate training, and evaluation systems based on merit and talent, are policies that, to a certain extent, tend to encourage training and professional achievement. The lack of competition among high-level research personnel, the tendency to be intolerant with colleagues that question the experimental design and other research procedures, the lack of students who stimulate their teachers to search for new knowledge, the difficulty in travel and contact with research workers of other institutions and other countries, the absence of a well-organized tecnical publication service, are, among other things, the factors that make the research worker stay happy with what he knows and diminish the pressure between what he could learn and what he already knows.

   Special care must be taken so the learning curve avoids the form presented on the following page. This graph shows that substantial increases in knowledge are achieved strictly during graduate study and that, in the rest of the researcher's professional life, no increase in knowledge is shown.

3. **Graduate Training (M.S. & Ph.D. Levels)** – This training is primarily aimed at preparing technicians to systematize their knowledge and to test theories. The level of systematization sought varies according to the capacity of the scientists and the development of a particular field of knowledge. The same applies to the complexity of the hypothesis to be

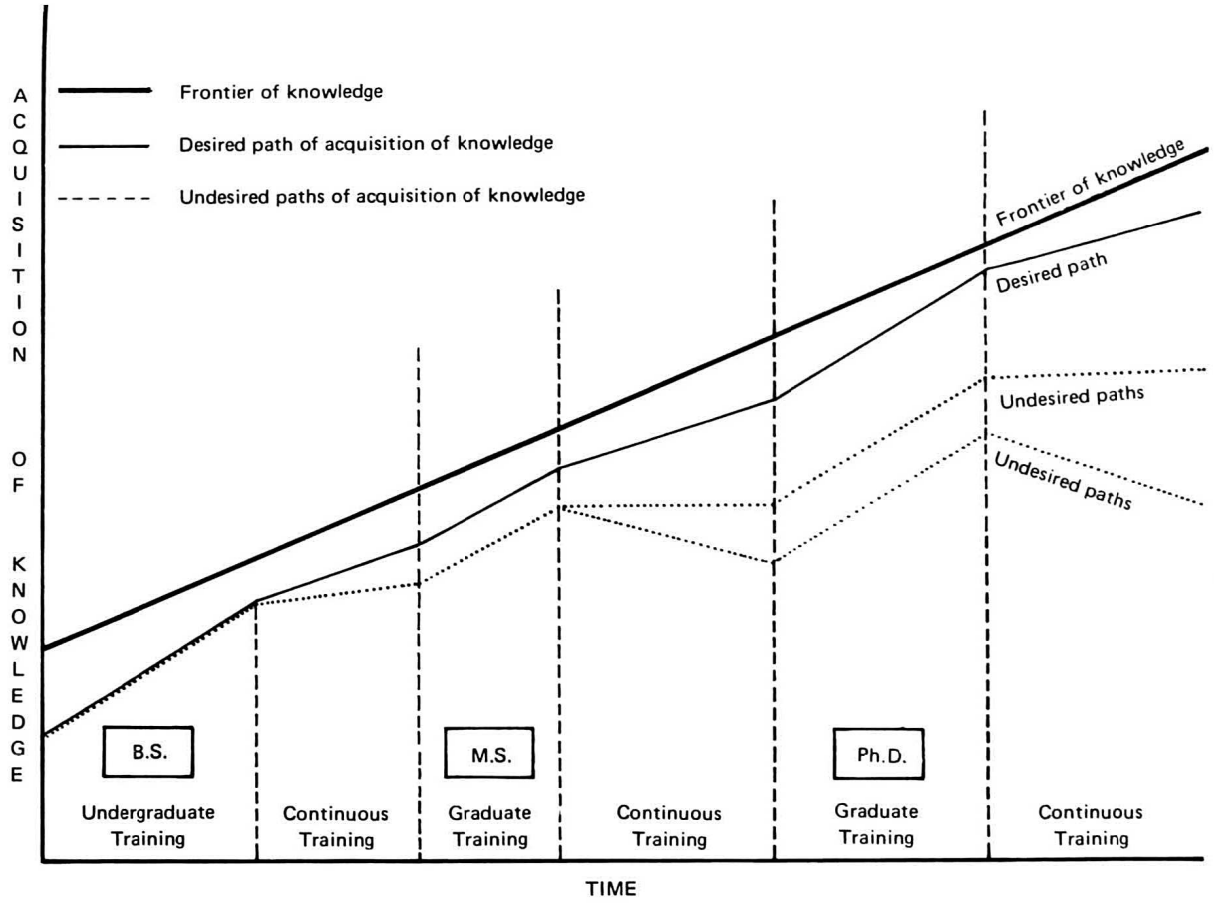

FIG. 1. Acquisition of knowledge during the professional life of a research worker (Desirable and Undersirable Paths Compared).

tested. During graduate study, there is a stage in which the student has to learn special techniques that are important to solving problems; however, this has to be understood as a teaching device that helps the student in the process of mastering theoretical knowledge. It is said that a graduate student is more interested in "why" rather than "how". As a result of this training, the technician must acquire a capacity to identify problems to be solved, and more than anything else, learn to be critical.

a) **Need for Graduate Training** – Graduate training is necessary for many reasons, among which the following deserve special attention:

   1. **Capacity to Understand** – Since agricultural technology is site specific, each country needs technicians with capacity not only to imitate, but also to understand. Otherwise, the technology generated will be irrelevant or potential progress rather small.

   2. **Access to Knowledge** – There is a large stock of knowledge that can be utilized in development of technology. Advanced training gives one access to this knowledge using a critical approach.

   3. **Effective Use of Foreign Technical Assistance** – Foreign technical assistance can never be effectively used without the presence of well-trained national personnel who have the capacity to absorb and adapt the experience of foreign technicans.

b) **Some Problems of Graduate Training** – Even though badly needed, experience has shown many problems related to graduate training. Two of them are mentioned below:

   1. **High Expectation Followed by Disappointment** – Initially, developing countries have great confidence in, and expect too much, from their M.S. and Ph.D. holders. Since they are not able to perform miracles, the result is frustration and disappointment among local authorities, followed by a decrease in the financing of graduate training, which though expensive, has a high return in the long run.

   2. **Resentment by Colleagues and Problems of High Level Appointments** – In many cases, the institutional structure is not prepared to receive the returning technicians, and the salary scale is not appropriate.

Since they are a few among a multitude of technicians with no graduate training, returning technicians are often faced with personal and professional neglect by their colleagues. The graduate training curricula do not teach them how to overcome these barriers. On the other hand, at certain stages of development, returning graduates with M.S. and Ph.D. degrees, without any appropriate experience or leadership training, are given high administrative positions. Thus, it is important for students from developing countries to receive, together with their specialized training, courses in leadership and how to overcome the resistance of a hostile environment.

c) **Selection of Candidates and Training Facilities** – One should have in mind that a large proportion of applied scientists are interested in applying knowledge rather than expanding scientific frontiers. This group should be trained in departments oriented towards application, and not strongly devoted to pure science. This group can also be sent for training in specialized subjects and within conventional graduate study systems where they do not need to go beyond M.S. training.

The Ph.D. candidates should be seen in a different perspective. They must have the ability and interest to learn theory. They must have distinguished themselves during the first two years of undergraduate work, mainly in the basic courses. Preferably, they should be younger and be able to be motivated towards emphasizing theoretical types of knowledge in their studies.

There is a great difference between academic programs in different countries, both at the graduate and undergraduate levels. In some cases the undergraduate program in one country corresponds to the M.S. program of another. If an undergraduate candidate comes from a developing country, he may require additional time to be trained up to the standards of a developed country before starting his graduate program. This fact tends to prolong the training period of candidates, and this situation is not usually acceptable to the authorities of developing countries. However, if no special precautions are taken, there is a tendency for high failure rates among students attempting to obtain an M.S. or Ph.D. degree in developed countries. These failures create a negative impact on both the students and the organization which financed the training program.

In the case of M.S. programs and non-degree specialized training,

it is desirable to have this training given under climatic conditions comparable to the country of origin of trainees. For Ph.D. programs this requirement is not as important. The quality of the Ph.D. training should be the major consideration in this case.

There is a natural sequence which, as a rule, must be observed to facilitate a better understanding of the potential for individual technical candidates for graduate training.

The technician should be hired soon after the has finished his undergraduate training,and should work at least two years in a research institution. If he shows exceptional capability, he should be sent to a Ph.D. program at the end of this period. Otherwise, he should be sent for an M.S. degree, preferably in his own country, or to non-degree specialized training wherever available.

After finishing the M.S. training, the technician should put in at least four years of work. From this M.S. degree group, a certain number will be selected to do further graduate work for Ph.D. degrees.

Here, care must be taken to match capabilities of individual candidates to the requirements of the course and academic department.

The total number of Ph.D. and M.S. research technicians will depend on the availability of financial resources and the cultural or development stage of each country.

d) **The Law of Large Numbers in Selection** – The selection for the career of researcher, from a large population of technicians, will assure the quality of research personnel, since selection techniques are more efficient when the population and the sample are large.

In this respect, the situation of developing countries is difficult. They have few technicians available,and from this group,only a small number are chosen to follow a research career. Therefore, there is a low probability that technicians,with the best qualifications and with the proper research aptitude,will be chosen.

Consequently, the selection process must be much more careful, starting with observation of potential candidates during their

undergraduate studies. At the same time, salaries should be made attractive to recruit the most gifted students.

Nevertheless, the best choice is to enlarge the population and the sample of technicians chosen for the research career. In the first stages of economic development, when this enlargement is impossible, the role of foreign technical assistance is enhanced, as well as the process of human resources development, so as to reduce the negative influence of the existing small number of technicians.

4. **Training of Research Executives** — Managerial control and administration of research centers requires special skills that can only be developed through appropriate training. It is recognized that a good administrator has the capacity to keep a coherent team of scientists dedicated to the achievement of the objectives of the institution. The capacity of a poor administrator to destroy an established research institution and research team is even greater. Thus the selection, training and evaluation of research executives or administrators is the major factor in the success of any research program.

It has been claimed that a research administrator need not be a research scientist. Although the experience is not clear in this respect, it still tends to support the opposite hypothesis. It is preferable that an administrator have some experience as a researcher, although he need not have a distinguished career as a research scientist. It would be desirable for him to have had varied experience in which he has been exposed to the various aspects of research, extension and public relations, in order to deal with these areas as a research administrator. He also must have proven leadership ability and a feeling for power.

The training of administrators must be designed to provide them with a broad outlook regarding science policy and economics. It must also be planned to cover leadership development and basic priciples of administration. The idea is train a researcher to be executive. He may or may not be trained in administration.

5. **Short Courses and Seminars** — There is evidence that research workers, who do not go through a regular graduate program or do not participate in academic life after graduation, tend to depreciate rapidly in terms of human capital. These research workers do not feel motivated to acquire

systematic knowledge, and overestimate what is conventionally known as "practical experience", so popular among farmers and politicians.

Through specialized courses and seminars within the research units, it is possible to partially create what universities offer in terms of basic training. The objective of these courses and seminars is to provide an interchange of practical knowledge among experienced researchers and to offer training for new ones.

It is even possible to arrange credit courses jointly with universities and to count these courses offered within the research system as graduate credits toward a degree. In addition, special courses should be organized by research units for extension agents and farm leaders.

6. **Training of Support Personnel** – This training should cover not only technical aspects, but should also be of a general nature to include objectives of the institution and specific functions of the unit.

Increased productivity by support personnel means increased productivity by the whole research system and thus by individual research workers.

The capacity of research workers to undertake projects and experiments is proportionate to the number of well-trained, competent support workers they can count on. These workers, however, do not obviate the necessity for continuous follow-up and close supervision of experimental plots or laboratory experiments. Without this continuous close supervision of work in progress, the research worker will not be able to develop his observational capacity to the extent demanded by the nature of research work.

Development of Research Environment

In order to achieve full institutional development, a research institution should create an appropriate research environment. The major criteria are as follows:

1. **Contact with Current Issues** – Research workers must be shown the importance of seminars and public debates and encouraged to participate in these events and must be able to travel within the country as well as overseas. This will help develop the well-rounded, mature scientists

demanded by applied research. In addition, the research institution will need to establish a socio-economic evaluation and technology assessment program through a broader interaction with intended beneficiaries.

2. **The Spirit of Organization** — It is very important to create an esprit de corps among all members of the research organization who must feel they are an integral part of the organization.

   Experiment station personnel should be made to feel proud in helping to build a scientific base for national agriculture and should be shown that their work is important to overall national development and growth.

   A special program should be organized to create this spirit among all levels of employees. This program should include lectures and public events with the participation of national and local leaders. Even though research scientists normally will be responsible for these activities, the creation of a caste system should be avoided so that all members of the establishment will feel they are part of the mission undertaken by the research institution.

3. **Spirit of Competition** — A healthy competitive spirit must be maintained between various private and public research units as well as between individual scientists. It is the function of the evaluation system to stimulate competition, to the extent that it promotes the most competent workers. A system of recognition of achievements through prizes and honors, that create a competitive spirit among scientists, must become an integral part of the research organization.

   Cut-throat competition must be avoided. The function of the administrator, in this context, is to warm up the institutional environment when it is apathetic and without motivation, and cool it down when rivalry begins threatening institutional unity and inter-institutional relationships.

4. **Salary Scales** — The salary scales should be designed to avoid the seniority system and the tendency to equate salaries. Its basic principle must be to give due merit to hard work and achievement. It must recognize that research workers who question established norms and procedures can be creative, and as such, the progress of research needs their contribution. A system of evaluation and promotion is essential in the administration of

salary scales. Since the use of this system is difficult, it is common to neglect it in practice. This constitutes a major error. The ideal solution is to have specialized personnel in the organization who continuously revise and adapt the evaluation and promotion criteria to the needs and realities of the institution. This is still an area where very little has been done and much work is needed.

5. **Publication of Results** — Every research institution must participate in founding and supporting scientific periodicals.

   It must encourage the research scientists to publish their results, both in national and international journals, or other technical publications. It must also encourage the publishing of non-technical material in the local press to reach the local populace. Participation in radio and television programs is also of utmost importance.

SUMMARY OF RECOMMENDATION AND CONCLUSION

The framework for management and institutional development of an agricultural research, discussed in this paper, leads to the following recommendations and conclusions:

1. The available evidence strongly supports the inference that organized agricultural research has been one of the most profitable national and international investments.

2. Managing the staff, which is equivalent to managing the research institution, together with an appropriate human resource development program, are the two major items in building research capability.

3. Flexibility must be built into every management decision.

4. Every research institution should produce some short-term results.

5. To avoid obsolescence, a research institution should have freedom of action to:

   a) Capture resources.
   b) Maintain a close relationship with university systems, the private sector and foreign research institutions.

c) Formulate its research policy.

6. The responsibilities between federal and state governments regarding agriculture research should be well defined.

7. Research units, dedicated to particular crops and resources should be located in the appropriate production areas. However, the research work should be distributed throughout the country since, research results are always site specific.

8. The professional staff of an agricultural research unit must be large enough to permit intensive in depth study of significant problems, application of different disciplines of knowledge, and a diversity of approaches. On the basis of relevant experience, a full-time staff of 30 to 100 qualified professionals represents the proper size for the staff of an agricultural research unit.

9. Even though financial stability is needed, in order to avoid overconfidence and potential apathy, researchers should be encouraged to finance some of their projects through contracts and patent rights and use idle resources of the institution for commercial production.

10. The process of creating knowledge is a continuum that starts with identification of a problem and terminates when the producer incorporates the technology resulting from the research into his production system.

11. A research institution should not neglect the university system, where the major areas of potential collaboration are: graduate training, including the M.S. and Ph. D. programs, elaboration of dissertations dealing with problems identified by research, use of consulting services and exchange of personnel.

12. The formation of human resources represents the major activity of any research institution and has the greatest potential for return on research investment.

13. Research institutions must create an environment in which all technicians undergo continuous training and professional improvement.

14. The spirit of a healthy professional competition should be maintained

without damage to institutional unity and inter-institutional relationships.

15. Salary scale should mainly reflect work and achievement and not seniority.

16. The training of research administrators should emphasize basic management principles as well as science policy and economics.

17. It must be remembered that the idea is to train an administrator and not make the administrator a scientist trained in administration.

18. Training should also be given to support personnel. This training should include presentation of the objectives of the institution as a whole as well as those of each research unit.

19. Research workers should be given a chance to travel inside and outside the country, participate in public debates and professional seminars and thus achieve overall professional maturity.

20. It is very important to create esprit de corps and institutional pride and to make every member of the staff feel he is an integral part of the organization and its mission.

21. In selection of candidates for graduate training the following sequence is suggested:

    a) Hire the young technicians upon graduation.
    b) Require that they work at least two years to acquire practical experience.
    c) Select the most promising and send them for a combined M.S./Ph.D. program.
    d) The other candidates, selected for the M.S. programs only, should preferably study in their native country or when possible in a country with similar climatic conditions.
    e) Newly hired M.S. - level technicians should work at least 4 years before being sent to Ph. D. programs.

22. In selecting the country and the university for Ph. D. training, the major consideration should be given to the quality of Ph. D. training and to

matching the capabilities of individual candidates with the requirements of the course. This will avoid failures and resulting individual and institutional frustrations.

23. In the early development stages, when only small numbers of graduates are available for selection as research scientists, the choice should be made during the last two years of undergraduate training. Use of international personnel in the initial stages of the institution may be the best way to compensate for the lack of qualified local candidates.

The three major recommendations of this paper are: (1) The key to success of every research institution must be the involvement of the research workers in a continuous contact and dialogue with their main clients, the farmers, since the creation of new technology must not be a one-way street. (2) The objective of agricultural research is not to displace all traditional practices with new technology, but rather to achieve a synthesis between available agricultural knowledge and the traditional method in a dialectical sense. (3) Finally, every research institution should identify the political forces that will give the strongest support to agricultural research and adjust its programs accordingly.