

EMBRAPA

(Brazilian Enterprise for Agricultural Research)  
Brasilia, D.F.

DEVELOPING AND MANAGING STAFF ON AN  
AGRICULTURAL RESEARCH INSTITUTION \*

by Eliseu Roberto de Andrade Alves

\* Paper presented at the workshop on "Increasing the Productivity and Impact of Agricultural Research", held at Gadjah Mada Univeristy, Yogyakarta, Indonesia, November, 1980.

DEVELOPING AND MANAGING STAFF OF AN  
AGRICULTURAL RESEARCH INSTITUTION

Eliseu Roberto de Andrade Alves\*

INTRODUCTION

In recent years an increasing awareness of the problems related to development and management of agricultural research and their 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 find 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

Managing the staff is managing the institution. The following assumptions were made in the process of developing various ideas presented in this paper:

- 1) The institution has an over all responsibility for agricultural research at the national level.
- 2) This responsibility is limited to research only and excludes both extension and education.

---

\* President of EMBRAPA (Brazilian Enterprise for Agricultural Research)

It 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 of this institution.

The political setting is a federal system where importance is given to cooperative aspects between federal and state systems in a joint effort to put agriculture on a scientific basis.

There is a social environment favorable to the development of science due to the following forces:

- a) Understanding that science is an important source of national power;
- b) The urban population which is dominating the political process is putting pressure on government to find solutions to growing food prices with the government realizing that the solution could only be found through the support of research institutions;
- c) Additional support to agricultural research comes from the producers, who see their production cost grow rapidly.

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

The institution has two major outputs: results of research and well trained research workers. It is the function of the administrator to make decisions that guarantee and facilitate the increasing flow of these two outputs. The first of these, results of research, is essential in obtaining an increasing support of the society. The second means that the institution is continuously increasing its capacity to produce research results, therefore, to become increasingly more useful to the society it is part of.

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 aimed to have a rather long life span. Many people confused 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. Still, a research institution is like a dam that takes years to be built. But, once built, it provides a steady supply of energy. This confusion has resulted in the fact that agricultural policy makers do not give enough 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) A legal organization that permits freedom to capture financial resources, management of its budget, a personnel policy appropriate for a research institution, close relationship with: the university system, the private sector and foreign research institutions. It must also have the freedom for formulation of its own research program.
- 2) It is essential to divide adequately the responsibilities between the federal and the state governments. Depending on the political development stage of the country, a major responsibility can rest with 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 only to certain states or regions. On the other hand, the local political power will hardly support research programs and institutions without being directly involved in its administration and financing.
- 3) The research stations 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 the research workers will be in continuous contact with producers. These contacts will inspire the research workers to concentrate their efforts on relevant problems and encourage them to continuously strive for professional achievement based on solving the farmers problems. The research units should specialize on a rather limited number of products or problems to avoid diffusion and dispersion of their efforts and keep their size to a controlled number of researchers, estimated between 30 and 100.

4) The traditional organization of research institutions is in the form of specialized departments set up by disciplines. The main function of these departments was 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 interest involved. On the positive side, this organization has the advantage of being able to avoid that the research institutions dedicate themselves only to the solution of immediate short term problems that, as the experience has shown, does 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 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 that have different interests than those of the dominating group, and may result in rather superficial research work, if certain precautions are not taken. The organization tends to benefit from group action in detriment to 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 team and the work is divided so that each scientist has his own project.

Frequent meetings have the purpose of following the development of the projects, avoiding major deviation 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, that is, the traditional disciplinary department organization with the multidisciplinary team organization. The Departments will be restricted to basic disciplines or to the service areas like laboratories, administration and others.

5) The resources allocated to research are usually limited. As a result, programming aimed at optimum efficiency becomes very important. Still the experience shows that a strong programming-planning system of research has a high cost in practice. A rigidly programmed research institution does not induce private initiative or participation of university systems. It does not follow basic procedures of scientific methodology, but tends to be rather general as opposed to specific, and over demanding in terms of time to be dedicated to paper work by the individual research workers which constitute the most valuable resource of any research institution. It tends to be more bureaucratic and centralized, is an excellent producer of paper 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 to the convenience of the research workers concerned. In other words the programming system must be as dynamic as possible.

The research program must be well balanced in terms of short term and long term projects. Giving needed priority to produce immediate results, that are easily adapted by the 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, can not be sacrificed. The program must also include those that have high risk since these are the ones that 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.

6) The nature of research activities requires a rather steady budget and can not afford wide fluctuation of the financial resources. Still, in practice, it should not provide excessive financial security in terms of research money to all scientists. At least a part of the resources should be given in a

competitive process where research workers will 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 to create a permanent interest on behalf of the institution in societal problems and develop the ability to relate and communicate with 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 the producers. Commercial activity of research units should not interfere with the major function of research and its administrative set up, if possible, should be separated.

- 7) The institution of applied research oriented towards obtaining short term results based on fast decision making has a tendency of being 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 potential of 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 that the leadership becomes over committed to the private interest 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 that 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 need for fast decision making that is not common with any decentralized democratic organization.

Decentralization of power could be achieved through giving certain autonomy to decentralized units without destroying over all power structure of the institution. Local autonomy, even though healthy from an organizational point of view, may not give a needed voice for research workers and thus has to be completed by other systems that gives direct representation to research workers, to producers, to consumers and to the extension personnel.

8) 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) It is vital to assure intensive and direct relationship with rural producers and private enterprise related to 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 the allocation of needed public and private resources for the research. To see and to hear are two different things. The researcher has to see in order to understand. He will hardly understand well a problem seen and reported by others. Certain details, sometimes crucial, escape the observation of a non-trained person;
- b) The process of creating knowledge is a continuum that starts with identification of a problem and only finishes when the producer incorporates into his production system the technology resulting from the research aimed at the solution of his problem. During this process there are various functions. It is common to differentiate two of them: The research and the extension. The first creates a body of knowledge. The second adds to the research results the information needed to make the research results adaptable by the producers. "The former creates the product, the latter sells it". These two functions could be located in the same institution or could be separated. In both cases the problems of integration are present due to the fact that the work of researcher and extension workers do not coincide, even though they may have the same objective, that is, to increase the productivity of agriculture and well being of the producers. The integration between extension and research lies, in the first place, in showing that the interest of two groups coincide and that one can not survive



without the other. Second, a way must be found through which each group participates actively in the work of the other, both at the level of contact with producer and the initial or continuous training programs. One finally should recognize that a certain amount of competition and even professional jealousy is healthy and productive in spite of what many people think..

- c) 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 needs a major effort and can not be neglected.
- d) University systems have high level trained personnel. The areas of potential collaboration are the following:
- Education: Training agricultural research technicians at advanced level, both short & long term, and specialized non degree courses.
  - Consulting: Providing technical services related to special problems identified by research.
  - Exchange of personnel: This means the University personnel will work in research institutions, occupying administrative and executive position when needed and vice-versa.
  - M.S. & Ph.D. Dissertations: Use of graduate students to prepare dissertations dealing with problems identified by research.
- e) 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 & 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 term and long term assignments help in skipping or accelerating institutional development stages leading young research workers to the frontier of knowledge.
- As a product of many years work advanced countries have been able to gather and develop germoplasm collections and a genetic base for plants and animals aimed at increased productivity. These collections have a great potential to contribute to any plant and animal breeding program in any part of the world.

### HUMAN RESOURCE DEVELOPMENT

In research there is no substitute for the quality of human resources involved. This is why the principal task of administration is to help to create an environment that stimulates high level performance based on creativity and protects these talents. The first part of this paper dealt with the organizational aspects of research institutions. The second part will treat various aspects directly related to development of human resources.

#### 1 - Human Capital

The formation of human resources represents institutional investment in human capital. One can not forget that human capital has depreciation rates that can be very high in an environment that does not stimulate a continuous search for knowledge and that affects the health and creates irritating internal frictions and alienation of individual technicians within the institution.

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

There are research institutions that still have elements that induce high level human capital depreciation. The leading contributors of this are: lack of wage differentials among those who produce and those who do not, lack of healthy professional competition, small numbers of research workers with advanced training, extensive bureaucracy, shortage of support personnel able to increase efficiency and output of individual researchers, and the lack of tradition in terms of administrative research leadership. This type of institutional setting contains some of the factors that puts a heavy risk on investment made in human resource development.

The effort to learn more is made as a response to lack of equilibrium between what one knows and what one could learn.

Factors that make for perception of this lack of equilibrium and that tend to perpetuate this perception resulting in permanent state of disequilibrium, as far as the individual's knowledge of his topic is concerned, should be maintained so as to motivate a desire among research workers to continuously increase and widen their knowledge. Differential salary possibilities for post-graduate training, evaluation systems based on merit and talent are policies that, to a certain extent, tend to perpetuate a state of lack of equilibrium. 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 that 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 technical publication service, are, among other things, the factors that make research workers stay happy with what they know and diminish the pressure between what he could learn and what he already knows.

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 rather fast rate. In this case the research scientist, instead of trying to diminish the difference between his knowledge and the frontier of

his field of science, lets this gap grow and is left behind more and more every day.

Special care must be taken so as to avoid that the learning curve maintains the form presented in the following page. This graph show that substantial increase in knowledge are achieved strictly during graduate study and in the rest of professional life no increase in knowledge is shown.

## 2 - The Spirit of Competition

A healthy competitive spirit must be maintained among various private and public research units as well as among 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 competitive spirit among scientists must become an integral part of the research organization.

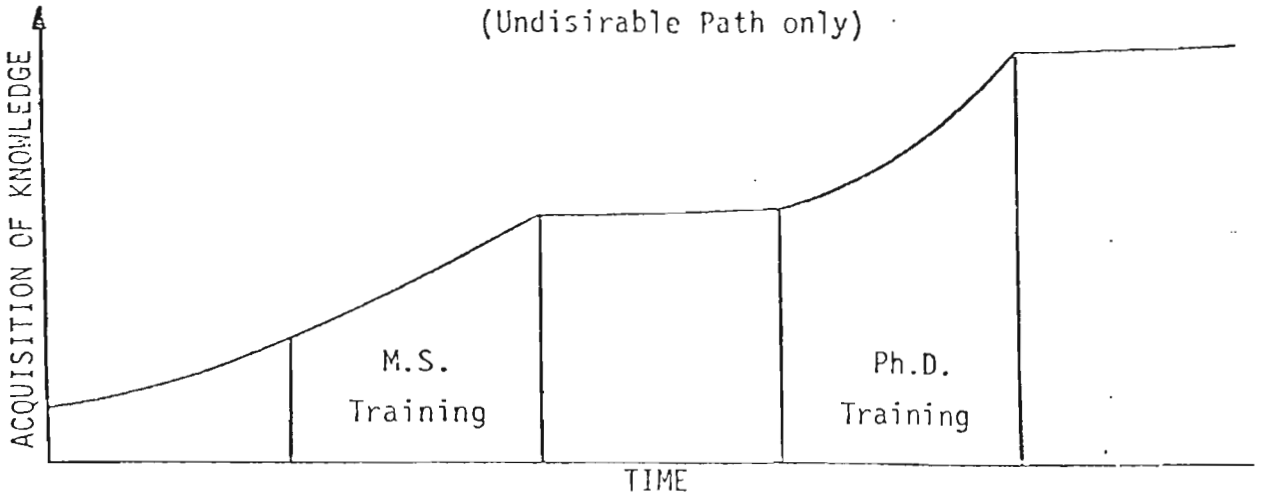
Cut throat competition must be avoided. The function of the administrator in this context is to warm up the institutional environment when it is apathetic and without motivation, and cool it down when rivalry starts creating a risk for institutional unity and inter-institutional relationships.

## 3 - Salary Scale

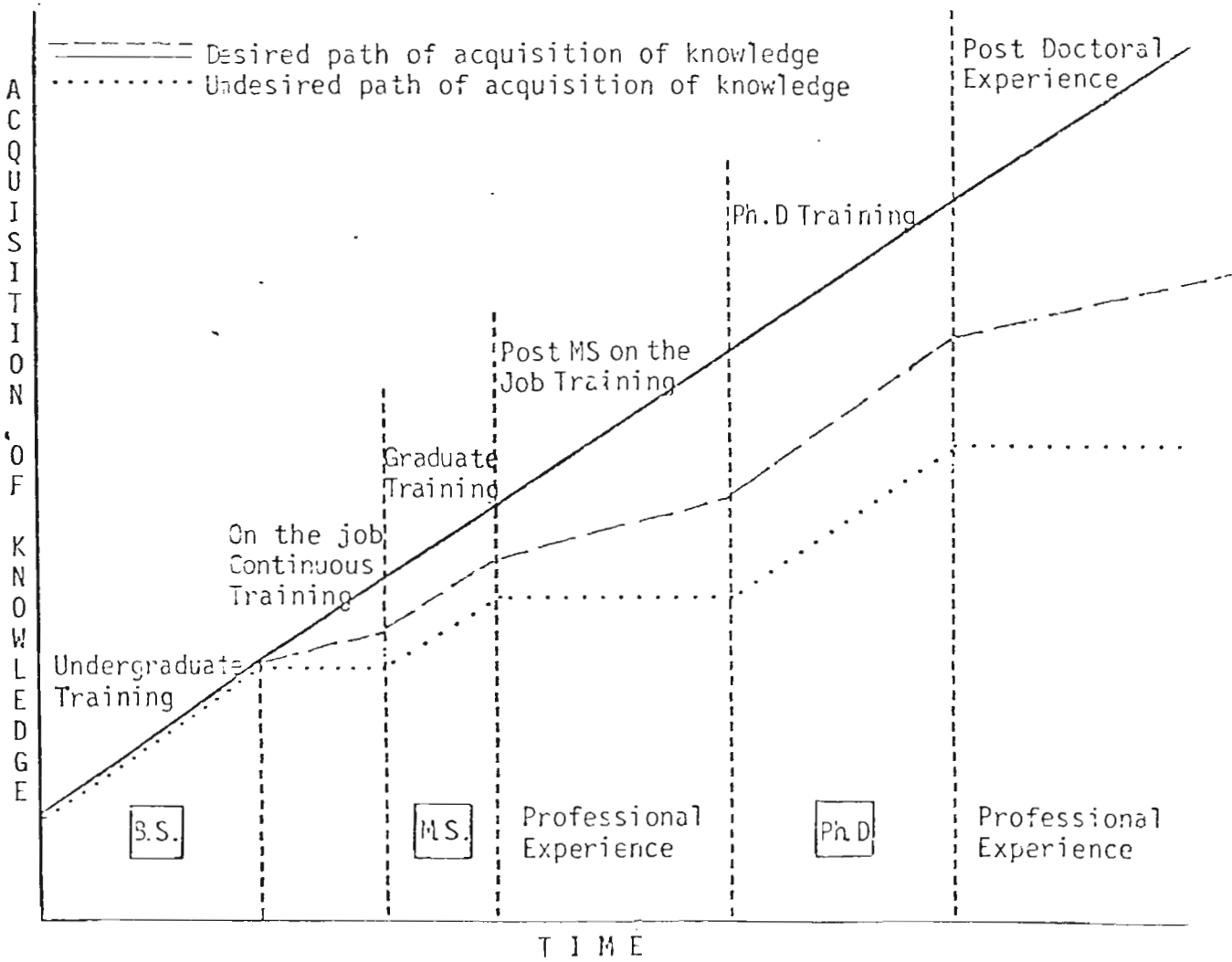
The salary scale should avoid the seniority system and tendencies to equate salaries. The basic principle must be to give due merit to work and achievement. It must recognize that research workers that question established norms and procedures can be creative and as such, the progress of research needs their contribution. The administration of salary scale needs a system of evaluation and promotion. 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 in the organization specialized personnel that continuously revise and adapt the evaluation and promotion criteria to needs and realities of the institution. Still this is an area where very little has been done and a great deal of progress and work is needed.

ACQUISITION OF KNOWLEDGE DURING THE PROFESSIONAL LIFE OF A RESEARCH WORKER

(Undisirable Path only)



(Disirable and Undisirable Paths Compared)



#### 4 - Publications of Results

Every research institution must participate in founding and supporting scientific periodicals.

It must encourage the research scientists to publish their results.

This applies to publishing in national and international journals or other technical publications. It must also encourage publishing of non-technical work in local press to reach local people. The participation in radio and television programs is also of utmost importance.

#### 5 - Training of Research Executives

Managerial control and administration of research centers need special skills that can only be developed through appropriate training. It is recognized that a good administrator has the capacity of keeping a coherent team of scientists dedicated to the achievement of all objectives of the institution. The power to destroy an established research institution and research team by a poor administrator is even greater. This is why the selection, training and evaluation of research executive-administrators is the major factor of the success of any research program.

There are those that advocate that a research administrator does not have to be research scientist. The experience is not clear in this respect, still it tends to favor an opposite hypothesis. It is preferred to have an administrator with some experience as a researcher even though he does not need to have a distinguished career as a research scientist. It would be desirable for him to have had a versatile experience, where he has been exposed to the various aspects of research, extension and public relation, in order for him to deal with these areas as a research administrator. He also must have proven leadership ability and lust for power.

The training of administrators must give them a general view particularly relevant to science policy and economics. It must also cover leadership development and basic administration principles. Still one always must remember that the basic idea is to train an administrator and not a scientist trained in administration.

## 8 - Contact with Current Issues

Due importance must be given so that research workers will participate in seminars and public debates where national problems are discussed. They must be able to travel outside and particularly inside the country. This will provide for the overall maturity of individual scientists that is very important for applied research.

## 9 - The Spirit of Organization

It is very important to create what the French call "Esprit du Corp" among all members of the research organization. They must feel as being an integral part of the organization.

They must be proud in helping to build a scientific base for national agriculture and feel that their work is important for overall national development and growth.

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

### GRADUATE TRAINING (M.S. & Ph. D. LEVEL)

This training is mostly aimed at preparing technicians to systematize their knowledge and test theories. The level of systematization aimed at varies depending on the capacity of scientists and the development of a particular field of knowledge. The same applies to the complexity of the hypothesis to be tested. During the graduate work there is a stage where the student has to learn special techniques, that are important to solve some 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 technicians must acquire a capacity to identify problems to be solved and more than anything else learn being critical.

## Need for Graduate Training

Graduate training is necessary for many reasons among which the following deserve special attention:

- a) 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.
- b) 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.
- c) Foreign technical assistance could never be effectively used without the presence of well trained national personnel who have the capacity to absorb and adapt the experience of foreign technicians.

## Some Problems of Graduate Training

Even though badly needed the experience has shown many problems related to graduate training. Some of them are mentioned below:

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

Resentment by Colleagues & Occasional High Level Appointments - In many cases the institutional structure is not prepared to receive the returning technicians. The salary scale is not appropriate. Since they are few among a multitude of technicians with no graduate training they are faced with a general boycott. The graduate training curricula does not teach them how to overcome these barriers. On the other hand, at certain stages of development, returning graduates with M.S. or Ph.D. degrees without any appropriate experience or leadership training are given high administrative positions. Thus, it will be 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.



## Selection of Candidates & 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 so vigorous in 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 ability and interest to learn theory. They should have distinguished themselves during the first two years of undergraduate work, mainly in the basic courses. Preferably they should be younger and able to be motivated toward emphasizing theoretical types of knowledge in their studies.

There is a great discrepancy in academic programs in different countries, both at graduate and undergraduate levels. It is possible that 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 by the authorities of developing countries. However if no especial precautions are taken, then there is a tendency for high rates of failures among students attempting to obtain a M.S. or Ph.D. degrees in developed countries. These failures create a negative impact on both the students and the organization which financed the training program.

In case of M.S. programs and non-degree specialized training, it is desirable to have this training given under ecological conditions comparable to the country of origin of trainees. For Ph.D. program this requirement is not all that important. The quality of the Ph.D. training should be the major consideration in this case.

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

The technicians should be hired soon after he finished undergraduate training.

He should work at least two years within 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. course preferably in his own country or to non-degree specialized training wherever it is available.

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

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 availability of financial resources and cultural or development stage of each country.

#### The Law of Large Numbers in Selection

The training of scientists can be regarded as the selection from a population of technicians, the career of researcher being offered to those selected.

The 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, only a small number is chosen to follow the research career. In that way there is a low probability that technicians with the best qualifications and a proper research aptitude be chosen.

That is why the selection process must be much more careful, starting with observations of potential candidates during the undergraduate studies. At the same time, the 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.

## SUMMARY OF RECOMMENDATIONS AND CONCLUSIONS

The framework for staff management and human resources development 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 government as far as agriculture research is concerned should be well defined.
7. The research units dedicated to particular crops and resources should be located in the appropriate production areas. However, the research work should be distributed all over the country given the fact that research results are always site specific.
8. The professional staff of an agricultural research unit must be large enough to permit intense in depth study of significant problems, application of different disciplines of knowledge, and diversity in approaches. On the basis of relevant experience a full-time staff of 30 to 100 qualified multidisciplinary professionals represent the proper size for the staff of an agricultural research unit.
9. Even though financial stability is needed so as to avoid over confidence 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 is not finished until the producer incorporates into his production system the technology resulting from the research.
11. A research institution should not neglect the university system where the major area of potential collaboration are: graduate training including M.S. and Ph.D., dissertations dealing with problems identified by research, use of consulting services and exchange of personnel.
12. The formation of human resources represents the major and highest paying investment of any research institution.
13. Research institutions must create an environment in which all technicians are undergoing continuous training and professional improvement.
14. The spirit of a healthy professional competition should be maintained without damage to the institutional unity and inter-institutional relationships.
15. Salary scale should mainly reflect work and achievement and not seniority.
16. Emphasis should be given to training of administrators that, in addition to some basic management principles, will include science policy and economics.
17. It must be remembered that the idea is to train an administrator and not to make the administrator a scientist trained in administration.
18. Training should also be given to the support personnel. This includes presentation of objectives of the institution as well as 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 over-all professional maturity.
20. It is very important to create "Esprit du Corp" and "Institutional Pride" and make every one feel as being 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) Have them work for at least two years.

- c) Select the most promising and send them for combined M.S./Ph.D. programs.
  - d) Those selected only for M.S. programs preferably should study in their native country or when possible in a country with similar ecological conditions.
  - e) New M.S. graduate technicians should work at least 4 years before being sent to Ph.D. programs.
22. In selecting of the country and the university and for Ph.D. training, the major consideration should be given to the quality of Ph.D. training and matching of 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 stage, since only small populations of graduates are available for selection as research scientists, it should be made during the last two years of undergraduate training. Use of expatriates to get the institution going at the beginning may be the only form to compensate for the lack of qualified local candidates.

The three major recommendations of this paper are that 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, for the creation of new technology must not be a one-way street. The objective of agricultural research is not to displace all traditional practices with new technology, rather it is to achieve a synthesis between agricultural knowledge available in the traditional method in a dialectical sense. And finally every research institution should identify the political force that will give highest support to agricultural research and adjust its program accordingly.