TRAINING AGRICULTURAL RESEARCH AND EXTENSION WORKERS FROM LESS DEVELOPED COUNTRIES:

An Examination of Training Approaches Used By The International Rice Research Institute and The International Maize and Wheat Improvement Center

BY

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To the agricultural research and extension workers in less developed countries this thesis is dedicated. May they continue to work closely with the peasants, cultivators and farmers of their own countries to help resolve the serious food problems that face the world today.

ABSTRACT

TRAINING AGRICULTURAL RESEARCH AND EXTENSION WORKERS FROM LESS DEVELOPED COUNTRIES:

An Examination of Training Approaches Used By The International Rice Research Institute and The International Maize and Wheat Improvement Center

Burton Eugene Swanson

This study analyzes why research systems in less developed countries have been largely ineffective in producing new technology to solve farmer production problems. The analysis suggests that research workers trained in foreign universities have internalized the normative structure of the educational and research institutions where they studied. When they return home they tend to continue working on theoretical problems using their newly acquired tools rather than focusing on the needs of local agricultural producers.

The main question addressed in this research was: Can the international agricultural research centers offer the type of training that will result in trainees working to solve local production problems? Or will they tend to perpetuate the research norms that place higher value on contributions to the body of knowledge in their respective disciplines? To address this issue a functional model of the research, development and extension process was developed wherein tasks associated with each aspect of the integrated process could be defined. Basically this model differentiates between "knowledge

generating" and "technology developing" types of research, as well as the "extension of technology" function, with knowledge being viewed as the essential building blocks of improved agricultural technology. This model was used to assess the work behavior and performance of former research and extension trainees from the International Rice Research Institute (IRRI) in the Philippines and the International Maize and Wheat Improvement Center (CIMMYT) in Mexico.

Three different approaches to the training of agricultural research and extension workers were described and evaluated in this study. These training programs are: (1) the CIMMYT Wheat Training Program, (2) the IRRI Rice Research Training Program and (3) the IRRI Rice Production Training Program. The data used in the analysis of these programs were based on an international survey of former participants. Responses to mail questionnaires were obtained from more than 75 percent of the more than 700 trainees who had participated in one of the three training programs. An analysis of the data indicated that former trainees assess each program in very positive terms, but that different training approaches, particularly in terms of the different educational objectives pursued and the different training methodologies used, resulted in significantly different types of on-the-job behavior after the participants returned to their home countries.

A research project approach to training resulted in participants who continued to focus on experimental research problems (knowledge generating types of research), which resulted in a relatively high

output of technical research papers. Participants undergoing on-the-job training in research programs that stressed technology development research were found to be very productive in terms of the number of research activities completed which were directly linked to the development of improved genetic and production technology. Finally most extension personnel trained in modern production technology appeared to be actively engaged in the delivery of technical information to agricultural producers, particularly through the use of high yielding production/demonstration plots; but most have been unable to devote much attention to training other extension personnel in their organizations or to conducting applied research trials, activities for which they are also trained. By looking at the over-all behavior of different training groups from each international center--in the context of the functional model of the research, development and extension process--it was possible to identify where serious institutional bottlenecks may occur in national research and extension programs due to the lack of trained technical personnel.

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CHAPTER I

CONCEPTUAL FRAMEWORK

Introduction

The lack of sufficient agricultural production to meet the minimum food requirements of expanding populations is a serious problem facing many population-dense nations of the tropics and subtropics. Until population increases are brought under control, and until adequate food supplies are available to meet the minimum nutritional requirements of the population, it will be necessary for these nations to more rapidly increase the quantity and quality of agricultural production.

To increase agricultural production, nations will need to solve certain key problems, which may be limiting output at the present time. In his book, Getting Agriculture Moving, Arthur Mosher summarizes what he considers to be the "essentials for agricultural development." These factors are: (1) markets for farm products, (2) constantly changing technology, (3) local availability of supplies and equipment, (4) production incentives for farmers and (5) transportation (Mosher, 1966, see pages 60-120). In this study, the concern will be focused on one of these so-called "essentials for agricultural development," namely, a constantly changing technology. In particular the concern will be

with up-grading and expanding the human resource component of those agricultural institutions that have the responsibility for developing and making available improved agricultural technology to agricultural producers. In addition, the focus will include attention to the organizational factors which tend to influence how these human resources are organized and utilized.

Given the shortage of "trained" agricultural research and extension workers in most Less Developed Countries (LDC's), the major thrust of this study is to examine how two international agricultural research centers--The International Rice Research Institute (IRRI) in the Philippines and the International Maize & Wheat Improvement Center (CIMMYT) in Mexico--are helping to resolve some of these technical manpower shortages through their training programs.

The study of training programs can be approached in different ways. Probably the most common procedure is to examine the effectiveness of training programs by measuring how well trainees have learned the specific concepts, information and/or skills taught. This type of evaluation procedure has been followed to some extent by both international centers mentioned above; most notable is IRRI's evaluation of "diagnostic and identification skills" used in rice production training (see IRRI's publication "Changing the Change Agent"). The evaluation technique used in that case is relatively simple--using both pre- and post-training examinations and then measuring the improvement in test scores.

The research reported here is based on a participant follow-up study of former trainees from the two centers. Therefore different types of analysis will be used. First, the respective training programs will be assessed from the standpoint of their contribution (usefulness) to the technical skill needs and requirements of research and extension workers once back home on the job. Second, the training programs will be assessed as institution-building tools in making available the appropriate types of technical training needed by national agricultural programs in carrying out the necessary research, development and extension functions to make available improved agricultural technology to agricultural producers in their respective countries.

To facilitate the reading of this thesis and to understand the conclusions reached, it may b helpful to briefly summarize the conceptual framework that is developed in the first chapter of the study and which is used in evaluating each training program.

First, it is known from the experience of the United States and other industrially developed countries, particularly in the temperate climatic regions of the world, that agricultural production can be substantially increased through the application of science. Therefore, if new and improved technologies of production are to be developed and made available to agricultural producers in LDC's, it will be necessary to develop appropriate agricultural institutions to carry out these functions. Furthermore, because of political, economic, and technical reasons, it appears warranted and necessary to build these agricultural

institutions principally at the national level.

Second, while the need for agricultural research and extension institutions is largely taken for granted, considerable resources must be expended to build these institutions in LDC's. Few attempts have been made to systematically study why existing institutions have been largely ineffective and therefore how they might be improved. Some agricultural development specialists have suggested that much of the agricultural research being carried out in LDC's is not rooted in the production problems of local producers, and for that reason, is inappropriate for meeting their needs. Observations by this investigator in several different countries support this general proposition.

The issue of the effectiveness of existing agricultural research institutions in the LDC's for producing a continuous flow of improved agricultural technology was selected as one of the primary problems for study in this research. In particular, the investigator was concerned with identifying and classifying types of research behavior into an orderly and logical system. Existing classifications, such as "applied" or "basic" research, proved to be both inadequate and confusing. To solve this problem, a functional model was developed and defined that appears useful in studying the work behavior of technical personnel assigned to crop research and improvement programs. This model, together with the experience of resource allocation within agricultural research institutions in the United States, provides an analytical framework for assessing the overall research behavior of former trainees.

The remainder of the first chapter deals with a detailed analysis of the institutional factors that may influence the technical working behavior of agricultural scientists.

The second chapter deals with definitional and conceptual aspects of training that relate to this study; and concludes with a survey of the training literature that applies to the training and education of agricultural scientists from LDC's (particularly in foreign educational institutions).

The next five chapters provide the body of the study. They describe the institution building strategy of each center and how this strategy is translated into training objectives, methodology, and operations. These descriptions are followed by empirical data on various aspects of the training program, including assessments by former trainees. These observations are followed by an overall evaluation of the respective training programs, with an analysis of background, organizational, and training factors which appear to be influencing the performance of returned trainees.

The Role of Research and Extension Institutions in the Agricultural Development Process

The Shift From Traditional To Modern Agricultural Technology

The traditional agricultural sector is characterized by relatively stable production at low levels, and constant or slowly changing technology (developed under survival conditions). Therefore, the combinations of production factors (given the

stable technology), are more or less fixed. Under these conditions, according to neoclassical theory, the scarce factor limits total production. Theodore Schultz summarized the situation in traditional agriculture when he pointed out: "There is at best little opportunity for growth from traditional agriculture because farmers have exhausted the profitable production possibilities of the state of the arts at their disposal. Better resource allocation and more savings and investment restricted to the factors of production they are employing will not do much for growth" (Schultz, 1964, p. 131).

Given this condition, there appear to be only two methods of increasing agricultural production: changing the state of the arts (i.e., new technology[1]) or increasing the supply of scarce resources. In the case of population-dense nations, which is the primary concern of this study, the limiting or scarce resources are generally both land and capital inputs. While some new land resources may be brought under production through colonization and resettlement programs, reclamation projects, and the more intensive use of currently cultivated lands (such as on large estates), the increased production potential of these presently unused land resources is being rapidly exhausted. Therefore, the means which appears to have the greatest potential for increased production, given the experiences of the industrially

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[1]For a general discussion of technology and its role in Agricultural and economic development see: Poats, Rutherford M., Technology for Developing Nations (Washington, D.C.: The Brookings Institution, 1972), pp. 5-50.

developed countries and the more recent experience of the Green Revolution in Asia, the Middle East, North Africa and Latin America, is through technological change.

A new technology of production, which shifts production frontiers forward, generally includes new capital inputs (such as seeds, fertilizers and pesticides) which can, in effect, be substituted for scarce land resources. But as Mellor and others have pointed out "...research results applicable to one geographic area can rarely be applied to another. This is particularly true of innovations which increase yields per acre..." (Mellor, p. 214). Thus it is apparent that governments in the tropics and subtropics must create research and extension systems that can develop and make available new technology to their agricultural producers.

The Need for Agricultural Research and Extension Institutions

The organizational basis for developing a continuous flow of improved and highly productive technologies of production is an effectively functioning agricultural search system. Cochrane summarized it by stating: "Research is the engine of agricultural modernization. From successful research come the new ideas, practices and technologies that can transform a traditional agriculture into a modern scientific agriculture. Once they begin to roll out of the research stations, the transformation of agriculture can occur at a rapid, even revolutionary pace." But, he adds, "...the building of a research organization capable

of turning out production-increasing practices and technology in a sustained flow is typically slow and fraught with untold difficulties" (Cochrane, 1969, pp. 218-19).

Likewise when the "new ideas, practices and technologies" do begin to roll out of the research stations, there is a need for an organized extension system which can transmit these improved methods to agricultural producers. Or, as Mellor puts it: "Final success of a program to develop agriculture depends, therefore, upon training tradition bound farmers to make economically sound decisions regarding new alternatives" (Mellor, 1963, p. 215).

Thus one of the key institutional problems that the LDC's are facing is how to build effective agricultural research and extension systems. Moseman summarizes the difficult task ahead: "...it is evident from the history of the evolution of the experiment stations within the United States Land Grant colleges and universities, and from the experience to date in U.S. technical assistance programs, that the agricultural research component will not be built into the resource structures of the developing nations unless there is a concerted effort to bring this about" (Moseman, 1970, pp. 29-30).

The Committee on Institutional Cooperation echoed a similar theme in a recent evaluative report prepared for the United States Agency for International Development (USAID): "Building an effective agricultural institution involves not only erecting and equipping laboratories and libraries, developing a technically competent staff and adopting appropriate rules and regulations. Even more

production-oriented research programs. E. O. Heady characterizes some of these arguments:

> "The productivity of resources used by the public to produce and increase the supply of technical knowledge for farming stands to be greatest in less developed countries when invested in applied rather than in pure or fundamental research. A less developed country can import knowledge of fundamental or pure research produced in other countries at little or no cost. While fundamental research basically has the same application in all world regions, applied research does not have equal international applicability" (Heady, 1965, pp. 164-65).

Hans Singer, in his paper on the problem of technological dualism, stresses a similar issue. While he points out that rich countries have a virtual monopoly on research and development expenditures, as well as in designating the frontiers of knowledge, this is only part of the total problem. In addition, "Much of the current expenditures of the poorer countries represents a hopeless attempt to compete from an inferior position in solving the same kinds of problems by the same methods, rather than those that would be suggested by their own conditions" (Singer, p. 24).

What Singer suggests is that while the less developed countries control only about two percent of the world's annual research and development expenditures, a substantial proportion of these resources are misdirected to research problems that are more relevant and useful to the rich nations. Singer terms this condition an "internal brain drain" and attributes it to the powerful attraction exerted by the rich countries "with their immensely superior facilities, and the glamour associated with

work on their self-defined 'frontiers of knowledge'..." (Singer, 1971, p. 24).

Lester Brown also stressed this same point of view when he said, "Until recently, most agricultural research programs in the tropical-subtropical countries were not only poorly financed, but lacked real relevance to the needs of local farmers. They tended to be patterned after programs in the rich countries, where the emphasis is on basic research. But advancing the frontiers of knowledge is a luxury poor countries cannot afford" (Brown, 1970, p. 52).

The emphasis on basic research that Brown alluded to appears common to many agricultural scientists in less developed areas. While this emphasis may partially explain why new technologies have not been forthcoming from national research institutions in the Third World, it is believed that the focus on the "applied/basic research" dichotomy is only part of the problem. There is little doubt that there is a time and place for basic research, but as Kenneth W. Thompson points out about the professional commitment of agricultural scientists working in LDC's, "Their objective must not be science in general but the single minded pursuit of a primary purpose, e.g., improving rice, corn or wheat production. They must be a cohesive group willing and able to sacrifice personal scientific ambitions to a common goal" (Thompson, 1973, pp. 56-66). C. P. McMeekan continues this argument by saying, "In practice it means applied rather than basic research....Acceptance of this view does not imply a lack of interest or non-participation in basic

research that turns up new knowledge, evolves new theories, or modifies old ones. Soundly designed and executed, applied research often does these things as by-products of the main objective" (McMeekan, 1965, p. 73).

The point that seems clear from this discussion is that the main objective of agricultural research conducted in LDC's must be the continuous output of improved agricultural technology to resolve production problems. Research, be it applied or basic, must be grounded in the real life problems of the agricultural community and must attempt to solve these problems. Knowledge should be viewed as a "means" to solving these problems, but the "end" will be an improved technology of production that will be relevant and useful to agricultural producers. Without this orientation being clearly specified and sought after, it is unlikely that the appropriate types of research will be undertaken.

Before proceeding any further into a discussion of the factors that may explain why inappropriate research orientations have developed, it appears useful and necessary to first clarify terms, present an overview of the research process, and determine the type of research emphasis that would be appropriate for an effective national agricultural research system. After presenting this material, the last section of this chapter will deal with an explanation as to how this problem may have developed.

important to its impact on agricultural progress is the development of a sense of institutional dedication to resolving the important problem of agriculture, the evolution of customs and traditions which favor this dedication, and the formation of a staff solidly committed to these goals and purposes" (Committee, 1968, p. 9).

It is necessary in building effective agricultural research and extension institutions, to take not only the physical, human, and technical resource into consideration, but to give attention also to the organizational factors which, in combination with the other factors, contribute to an institutional orientation and working environment that will lead to the solution of the serious agricultural production problems in LDC'S. The remainder of this chapter will focus on organizational factors which are critical to the effective utilization of manpower and other resources available within national agricultural institutions.

The General Research Problem

The Lack of Effective National Agricultural Research Institutions

The recent experience of the international research centers (particularly IRRI and CIMMYT) has demonstrated that many of the theoretical and methodological tools that have been developed in the temperate regions of the world can be applied to agricultural problems in the tropics and subtropics. These successes have produced mounting pressure for agricultural research institutions in these countries to quickly shift into practical,

The Need to Redefine Types of Research Activities

Unfortunately the discussion of research orientation has evolved around the use of two very mis-used and misunderstood terms: applied and basic research. The problem is that these terms have general rather than specific meanings and the use of them frequently tends to confuse, rather than clarify the issues being discussed.

Vimal Shah suggests that research can be differentiated as either pure (basic) or applied by observing the objectives of the research investigator. "The objectives of a research may be "pure" in the sense that they aim at accumulation of knowledge for its own sake, or they may be "applied" in the sense that the researcher, his sponsoring agency or some other organization is interested in applying the findings of the research to some practical use." Shah goes on to say that "The terms 'pure' and 'applied' indicate only the polar ends of a continuum." (Shah, 1972, p. 1). While Shah's idea of differentiating between types of research on the basis of objective or purpose and the idea of a research continuum appear very useful, his definition for "pure" research appears to be very limiting for the purpose of this study. Furthermore as Kellogg points out, "...essentially all important, original agricultural research has been directed toward practical problems" (Kellogg, 1964, p. 83). The concern of this study is not with research which aims solely at the accumulation of knowledge for its own sake. In particular what is needed is objective criteria for differentiating between types of

research in the middle of this continuum and extending through applie research at the other end.

A Functional Model for Viewing the Research, Development and Extension Process

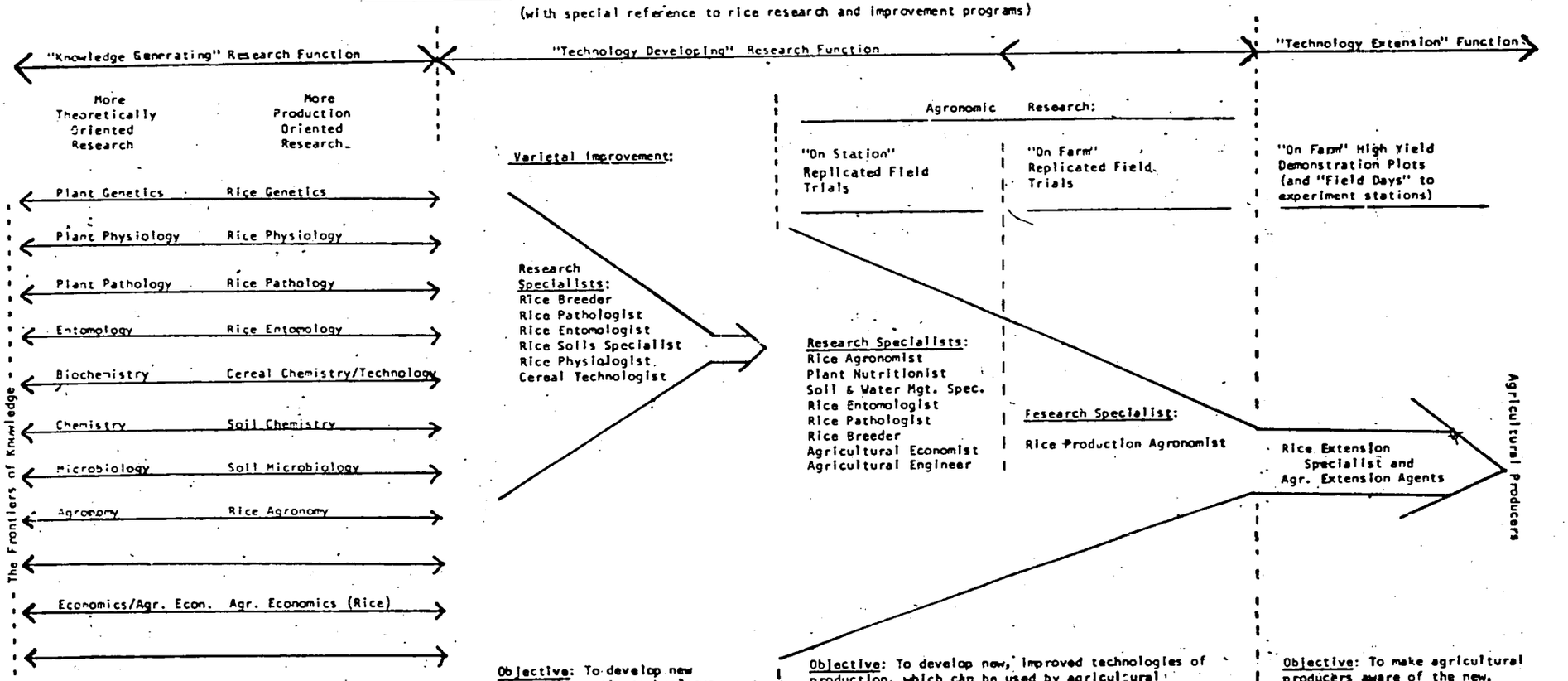
The functional model which appears on the next page is a combination of existing concepts and terms that have been formulated to meet the needs of this research--which is concerned with wheat and rice improvement programs. The objective is to identify and define major types of research within a research continuum or process that would be found in an effectively functioning crop research and improvement program. In addition the model includes and is integrated with the technical aspects of the subsequent extension process.

The functional model, therefore, flows on one hand from the basic scientist, working at the highly theoretical frontiers of knowledge, through a series of linked research and extension operations which results in improved agricultural technology being made available to agricultural producers at the other end of the continuum. (Note: while it is not included in the model as presented, it is assumed that there is a corresponding feedback process or system, flowing the opposite direction; whereby new problems are identified and brought to the attention of the appropriate research program or section within the research institution.) In general, knowledge-generating research is equated with basic or original research and technology-developing research is equated with applied research.

Figure I-1

FUNCTIONAL MODEL FOR VIEWING THE RESEARCH, DEVELOPMENT AND EXTENSION PROCESS IN AGRICULTURAL DEVELOPMENT

(with special reference to rice research and improvement programs)



Objective: To expand the body of knowledge within each field of study or discipline.

Function: To conduct experimental research in the laboratory, greenhouse or experiment station. Research experiments conducted in the laboratory and greenhouse are generally considered to be somewhat more theoretical than field experiments.

Output: A continuing flow of research publications or technical papers. This information can be used by agricultural research workers for technology developing purposes and for further expanding the body of knowledge within each field of study.

Objective: To develop new improved genetic technology; which should be highly productive, with resistance or tolerance to economically important diseases, insects and problem soils.

Function: Operating a varietal improvement program including: making genetic crosses, screening and selecting elite germ plasm, varietal testing, etc.

Output: A continuing flow of genetic materials (germ plasm) and new improved varieties.

Objective: To develop new, improved technologies of production, which can be used by agricultural producers to increase farm output. These new production technologies should be developed as new production inputs (seeds, chemicals, etc.) become available and as economic, supply and resource factors change in the target area.

Function: Conducting replicated field trials, first on the experiment station and later on farms, to develop integrated production functions for the factors of production.

Output: A continuing flow of new and improved "packages of practices" or production recommendations.

Objective: To make agricultural producers aware of the new, improved production technology and to assist producers in adopting the improved technology.

Function: Conducting high yielding production plots, based on the production recommendations of production agronomists and other research workers; teaching, demonstrating and generally assisting agricultural producers to adopt the new and improved "packages of practices".

End Result: Adoption of improved production technology by agricultural producers.

All scientists conducting knowledge-generating research are in a sense working at the frontiers of knowledge and are in fact creating new knowledge, thereby contributing to the theoretical structure of their respective disciplines. The main difference between types of research within this category are (1) the level of abstraction or generalization at which the research is done (highly theoretical versus more production-oriented) and (2) the purpose for which it is done. Generally knowledge-generating research, as it is used in this study, refers to an experimental research activity that results in the creation of new knowledge. Purpose is something that is difficult to define, except when taken in the context of the over-all research process and by observing the main types of research output.

While all knowledge-generating research activities included in this study are assumed to be essentially production oriented, research experiments conducted in a laboratory or greenhouse are generally considered to be a step further removed from the agricultural producer than field experiments. Thus significant research findings resulting from a laboratory or greenhouse experiment would probably necessitate further study under field conditions before this new knowledge would be utilized in technology developing research and built into a new variety or a new package of practices.

Technology-developing research uses or applies existing theoretical structures and knowledge, as well as methodological tools, in producing new agricultural technology. Two general

types of crop technology were included in this study: (1) genetic technology and (2) agronomic technology.

Generally genetic technology refers to improved crop varieties which have an increased production potential. This increased production potential is due to certain physiological changes in the genetic structure of the plant (such as increased fertilizer responsiveness, photoperiod insensitivity, improved plant type, etc.) combined with genetic resistence or tolerance to important limiting factors of the crop, such as diseases, insects, drought, problem soils, etc. In addition, this increased production potential must be coupled with acceptable grain quality characteristics.

Agronomic technology refers to the "package of practices" which must be developed to accompany existing and newly developed forms of genetic technology. This bundle of technological components includes factors such as: fertilizer and pesticides (capital inputs), as well as cultural practices such as: date, depth and rate of planting, seedbed preparation etc. It is well known that these agronomic factors of production greatly affect crop yield and in most cases the theoretical reasons for these effects are known. The job of the research worker in this case is to conduct extensive replicated field trials--first on the experiment station and then on farms--to determine the optimal "package of practices" that the farmer can use in exploiting the genetic potential of the variety, given available resources and economic constraints.

Extension technology refers to those activities which are used primarily by extension workers (sometimes the activities of research workers carry over into this functional area) to make information about improved agricultural technology available to farmers. These activities consist of a variety of methods of advising and teaching farmers with particular attention in this study given to high yielding production or demonstration plots.

The main point in differentiating the research and extension process in this way is to provide an analytical tool whereby research can be classified by function while not being bogged down in a semantical discussion as to whether research is basic or applied, theoretical or production oriented, etc. Understood in this model is that research (and possibly extension) workers may operate in one or more functional areas--possibly across the complete functional spectrum from the frontiers of knowledge to the release of new technology to farmers. This functional definition will be used later in the study in determining if certain research areas are being neglected within the training strategy of each center given the work behavior of trainees after they return home. The concern is to identify potential bottlenecks in the research and extension process which may occur due to technical manpower deficiencies or an improper research orientation.

Research Orientation and Emphasis Within an Effective National Agricultural Research System

To gain a perspective on research orientation and emphasis as carried on within an effective national agricultural research

system, it is useful to look at some comparative data on the United States. Before examining this data, however, the following observation should be made and will be discussed in more detail later. The common impression that many foreign students apparently carry away with them, after studying at agricultural colleges in the United States, is that much of the research conducted here is theoretical or basic knowledge-generating research. In fact, most foreign students, in the process of obtaining a graduate degree in technical agriculture in the United States, must write a thesis based on original research. The point that too few people realize is that the technology-development function important to developing agriculture occurs away from college campuses.

According to data provided by H. L. Wilche and H. B. Sprague, more than half (56%) of public agricultural research expenditures (USDA and state experiment stations) were allocated to applied research, with 41% being spent on basic research and 3% being spent on engineering and development (mechanical technology). Less apparent to the casual observer, however, is the magnitude and emphasis of research expenditures in the private sector. In 1965, $460 million dollars or 54% of the total U.S. agricultural research budget was expended in the private sector. Of this only 9% was allocated to basic research, with 50% being spent on applied research and 41% going for engineering and development. By reorganizing these data and excluding engineering and development expenditures from the comparisons (since mechanical technology is of minor importance in this study), the

following research orientation or emphasis was found.

TABLE I-1

Comparative Emphasis on Basic and Applied Research in the United States during 1965

	Annual Research Expenditures (in millions of dollars)			
	Public	Private	Total	%
Basic Research	161.5	41.4	209.9	31%
Applied Research	220.6	230.0	450.6	69%
Totals	382.1	271.4	653.5	100%
(Engineering & Development)	11.8	188.6	200.4	

Source of Data Used: H. L. Wilcke and H. B. Sprague "Agricultural Research and Development by the Private Sector of the United States" in Agricultural Science Review, Vol. 5, No. 3, 1967, page 3.

Given the need for applied research to translate basic research findings (knowledge) into improved agricultural technology: and given the current balance between applied research (69%) and basic research (31%) in the effective agricultural research system of the United States, it must be concluded that resource allocation to agricultural research in LDC's which gives little emphasis to applied research would not stimulate production. These data also give strong support to the recommendations that were summarized earlier (by different agricultural development specialists) that agricultural research institutions in LDS's should

emphasize applied research activities.

To conclude, it appears that knowledge-generating research has received most of the attention in the past--particularly because of the glamour associated with working at the "frontiers of knowledge" which is accentuated by the professional associations and scientific journals. Yet over two-thirds of the research effort in the (effective) agricultural research system in the United States is devoted to the more routine, less visible and less prestigous task of converting knowledge into usable, improved agricultural technology.

In most LDC's the private research sector is very small or nonexistent. Therefore any research, but particularly the applied research, must be carried out in the governmental research institutions. Given the experience of the United States, it would appear that a general rule of thumb, concerning the balance between knowledge-generating and technology-developing research would be not to expend more than 30% of the national research budget on knowledge-generating research. In addition, knowledge-generating research should be closely tied to research activities and problems within the technology-developing function--more than likely being carried out by the same research workers.

Factors Affecting Agricultural Research Orientation

To recapitulate the discussion thus far, an attempt has been made to develop a series of linked propositions which all serve to narrow the parameters of this study and to develop a

conceptual framework for the training study. Briefly these propositions are the following:

1. If agricultural development is to occur, then a necessary condition will be increased agricultural production.

2. If agricultural production is to be increased, then a necessary condition will be a constantly changing (improving) technology of production.

3. If a continuing flow of agricultural technology is to be developed and made available to producers, then a functionally integrated research and extension system will need to be established and institutionalized.

General Research Problem: The failure of existing agricultural research (and extension) institutions to develop and make available a continuing flow of improved technology to agricultural producers in the less developed countries.

Hypothesis: The failure of existing agricultural research institutions to develop improved agricultural technology is largely due to an inappropriate research orientation--which stresses knowledge-generating research rather than technology-developing research rooted in farmer production problems.

This hypothesis has been supported thus far by (1) agricultural development specialists who have written on this subject, and (2) the effectiveness of applied research found in the agricultural research system of the United States.

In the process of developing and refining this hypothesis, a functional model was introduced and defined to serve both as a conceptual framework for viewing the research, development and extension process and as an analytical tool to be used later in the study to assess the work behavior of former trainees.

The remainder of this chapter will be devoted to a theoretical discussion and analysis of this general research

problem: first to give additional support to this hypothesis by providing a theoretical explanation as to how this problem may have developed, and second to use this discussion as a means of generating possible solutions to this problem that might be relevant to international research centers in implementing their manpower and institutional development programs. For the reader not concerned with the theoretical issues that may have contributed to this problem, it is suggested that the bulk of Part III be skipped and that reading begin with the final two sections of this chapter.

Institutional Transplants: The Problem of Research Orientations

Phase I: Transplanting Agricultural Research Institutions

Following the Second World War, when the industrially developed nations (primarily the United States) got into the technical assistance business, agricultural development was given high priority. Speed seemed of the essence. Action-oriented programs in research, extension, credit, etc. were implemented as rapidly as possible. Since most countries had, at best, a poorly developed institutional infrastructure for agricultural development programs, the first thing some technical assistance advisors did was to transplant the formal institutional structures that they were familiar with back home into the respective national government bureaucracy in which they were working.[2]

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[2]See Brown, Marion R., "Agricultural 'Extension' in Chile: A Study of Institutional Transplantation," in The Journal of Developing Areas (January, 1970): 197-210, as an example of a documented

Phase II: The Reformulation of Working Rules

The next step was to mobilize whatever trained administrators technicians, etc., were available to staff these organizations. In many cases the personnel were poorly trained and had only a vague idea as to what they were expected to do. Once the institutions were established, policy decisions were taken over by local officials unfamiliar with applied research processes. While they may have seen the abstract relationship between technological change and increased productivity, they lacked the experience, expertise, and staff to translate this concept into practical research programs that would achieve agricultural development objectives. In addition, since political leaders as well as the agricultural producers had never experienced rapid technological change in the agricultural sector (with the possible exception of export crops controlled by foreign firms), they were unaware of the production potential that existed in transforming traditional agriculture and the process of achieving these changes.

The absence of external political pressure from the agricultural community and the lack of clear internal direction resulted in the development of a research bureaucracy that turned its attention to problems affecting its own survival. In the language of goal theorists it would appear that most transplanted agricultural

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(Footnote 2 continued) case where extension institutions from the United States were directly and rather unsuccessfully transplanted into a new and different national situation.

research institutions experienced a "displacement of goals, whereby research personnel view the research organization as a terminal goal or end in itself, rather than a means to solving farmer production problems. Erven Long specifically mentioned this as an important problem when he said, "In Research, a change of attitude as to the basic purpose is required, anchoring it solidly in the development needs of the country's agriculture, rather than treating it as an end in itself" (Long, 1964, p. 12). The resulting behavior of research personnel--as sometimes described by foreign technical specialists in unofficial reports and in other types of non-empirical statements--is to conduct "paper" research write reports, carefully follow bureaucratic rules, avoid decisions that could jeopardize security, appear busy, and, in general, work to minimize strains and maximize personal rewards and prestige. In organizations where this type of research worker behavior is frequently found, there appears to be an absence of working rules that direct research workers to solving farmer problems. Instead, the client public of the research organization is the research personnel and superiors in the government hierarchy.

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[3]Displacement of Goals: A general concept discussed by Robert Michels as the "iron law of oligarchy" in Political Parties, but later more clearly differentiated whereby "an instrumental value becomes a terminal value" (Merton, p. 51). For a brief discussion of this concept see Lipset, S. M., "Introduction" to Michels, R., Political Parties (New York, The Free Press), 1962, pp. 15-39, and Merton, R. K., "Bureaucratic Structure and Personality," in Etzioni, A., A Sociological Reader on Complex Organizations, Second Edition (New York, Holt, Rinehart, and Winston, Inc.), 1969, pp. 47-59.

Phase III: The Shift to Professional Research Norms

As technical assistance agencies became aware of the ineffectiveness of agricultural research institutions in Third World countries, they began trying to build alternative institutions. They gave priority to training in various technical agricultural disciplines in an attempt to up-grade research and organizational skills of research workers. They also perceived the lack of adequate scientific equipment, laboratories, etc. as an important obstacle to effective research. Since this latter obstacle was directly tied to budget and foreign exchange constraints, the problem could be, and was to a large extent, resolved by grants from technical assistance programs. It appears that training research personnel was viewed as a similar obstacle, so increasing numbers of scholarships and fellowships were soon forthcoming.

Research personnel were selected in increasing numbers by various technical assistance programs to be trained in foreign universities. Over a period of more than two decades an insufficient, but still significant number of agricultural research personnel in most LDC's received advanced academic degrees. In retrospect, however, it now appears that this approach to meeting the technical manpower needs of agricultural research institutions may have produced as many new spinoff problems as it solved. It is believed that many of the new problems can be attributed to what might be described as a shift to professional research norms. This shift can be explained by a combination of the perceived

prestige of foreign universities on the part of the foreign student and, perhaps more importantly, the day-to-day exposure of the student to the faculty, his advisor and graduate committee in these universities. This experience has served to socialize the foreign student into accepting the professional norms of the academic discipline with which he now identifies.

While a professional identification is generally thought to be a positive and important part of a young scientist's development and should be encouraged, if improperly oriented, it can have negative results. What is suggested is that most foreign students have little or no contact with productive applied research scientists in the agriculture universities where they study. Since degree programs require "original" research, it is logical to expect most foreign graduate students to work more closely with the faculty doing fundamental research within a discipline than in a multi-discipline applied area. Research topics are selected by the foreign student or given him by his major professor and seldom focus on agricultural problems ba k home (Wharton, 1959, pp. 26-27, Mellor, 1963, pp. 218-21). More often research topics are closely tied to the on-going research of the professor or his colleagues. Since increasing amounts of research funds available to colleges of agriculture are for fundamental research and since the professional associations and their corresponding professional journals tend to stress fundamental research, it is common for most research-oriented universities to evaluate their faculty members largely on the basis of their publication

and citation record. It follows that these factors will influence the normative thinking that is passed on to foreign students. When a student returns home with a prestigous foreign degree and 2-5 years of day-to-day exposure to basic research thinking, it should not be surprising to see the type of research he feels to be important. In other words, while the education a research scientist receives in many foreign universities may be essential to providing the necessary theoretical and methodological background needed, the accompanying research skills and attitudes learned may be completely inappropriate under different institutional and agricultural conditions of developing countries.

It appears that these "professionally" oriented scientists take their research direction and problems from the larger professional peer group with which they themselves identify. These professional groups have the majority of their members in the industrially developed countries (largely the United States). Therefore, the professional norms reflect what scientists in the industrially developed countries feel to be important areas of concern within their fields of study. The research worker who subscribes to these professional norms, in effect, looks to the professional organization as his client public. Since the principal means of receiving recognition and rewards within the professional group is to publish in the professional journals and to present research papers at professional meetings, this largely determines the type of research that is sanctioned by the group and which in turn can be carried out by the individual research worker.

Now we can explain the problem of a misdirected research orientati vis-a-vis the individual research scientist. The next step is to examine how this inherited professional orientation permeates the entire research organization.

Phase IV: The Transition to Working Rules Reflecting a Professional Group Orientation

During the period of the fifties and sixties, as increasing numbers of "trained" research workers returned home from foreign universities, they began to make up an important professional group within each national research institution. Since these returning scientists have prestigious degrees from foreign universities they move rapidly into high level administrative and policy positions within the research organization (Mellor, 1963, p. 217; Wharton, 1959, p. 31). It follows that with the movement of professionally oriented scientists into the research hierarchy, there will be a gradual transformation of working rules from those oriented to the problems of the research bureaucracy, to new rules oriented to research problems considered important by the professional group (or a combination of the two). At this point, the professional group(s) becomes the dominant client public of the research organization. This process can be described, in the language of organization goal theory, as an atypical example of a "succession of goals."[4] It is atypical since it represents a shift

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[4]Succession of Goals: results when an organization meets original goals, but is able to identify and transfer organizational focus to new goals, which are also relevant to the client public (see: Sills, pp. 175-86, and Blau, 1955, pp. 193-200).

from the basically negative, or organization survival concerns of before (ie. the organization viewed as a terminal value) to new, relevant research problems--particularly as perceived by the professional oriented research personnel themselves.

Working Rules Reflecting "Professional Group" Norms: An Institutional Condition of "Trained Incapacity"[5]

While the shift from largely paper research to knowledge-generating research can only be viewed as a significant improvement in research organization orientation and resulting activities, it is necessary to appraise this emerging situation in the context of the technology requirements for agricultural development. As was mentioned earlier, nearly 50% of the research carried out by state colleges of agriculture in the United States is classified as basic research. However the majority of the basic research is conducted by the academic faculty on the university campus--the faculty that works most closely with the (foreign) students in each academic department. The conduct of more fundamental research within the university or public research institution works very well in the United States because this type of research is expensive and the direct output (knowledge) need not be immediately applicable to the needs of the people. But even larger in the United States is the well developed technology-developing research infrastructure (much

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[5]Trained incapacity refers to a condition where "actions based upon training and skills which have been successfully applied in the past may result in inappropriate responses under changed conditions" (Merton, 1969, p. 50).

of it now being carried on by private industry) that can apply and integrate knowledge to develop improved technology used in the agricultural and food industry to increase the quantity and quality of agricultural products.

A problem occurs when newly educated agricultural research workers go home, highly interested in knowledge-generating types of research, but are placed into a situation where the corresponding technology-developing research infrastructure does not exist. The result is that an institutional bottleneck is created because of the lack of manpower and programs to translate knowledge into usable forms of technology.

Further serious questions have been raised about the relevance of the knowledge-generating research that is conducted. An institutional bottleneck of this type would be expected to limit or even stop the flow of information in both directions. Therefore, unless the knowledge-generating research scientist goes directly to the farmer's field, he would not be familiar with the types of problems to be solved. In fact, Hans Singer says, "...scientists and technologists of the developing countries are themselves trained and conditioned to accept the frontiers of knowledge as being where they are for the richer countries--frontiers which, in terms of relevance, may be as far removed from the problems of the poorer countries as the moon is from the earth" (Singer, 1971, p. 28).

In summarizing the growth and development of transplanted agricultural research institutions, it is necessary to conclude that

professional norms (working rules) which emphasize knowledge-generating research--while being a considerable improvement over the organization survival rules that m y have dominated many national research organizations in the past--are still dysfunctional to the research organization, given the functional context in which agricultural research is being viewed in this study. This is not to say that fundamental research does not have an important and useful role to play in the long run development of the agricultural sector of Third World countries. Obviously it does. What the evidence suggests, however, is that there is a question of proper balance and timing.

As mentioned previously, there is a considerable reservoir of theoretical and methodological tools that are available in the agricultural sciences which are appropriate for technology development. To be useful, however, these tools must be used or applied in research programs that focus on farmer production problems. In research organizations clearly dominated by professional norms, it appears quite likely that original research will be oriented to problems of rich nations.

Institutional Factors Influencing Research Orientation

Two factors emerge from the preceding discussion concerning the research orientation of many institutions in the LDC's. These factors will be examined separately.

The Client Publics of Agricultural Research

The agricultural research worker has two main publics (external to the organization) which he must serve or pay close attention to. The first and most obvious clientele of agricultural research is the agricultural producer or agricultural community. Another public to which the research worker is also closely attuned is his professional peer group (association). The research worker must stay abreast of new developments in his field so that relevant techniques, materials, research methods, etc., can be built into his research program to further assist the agricultural community.

While the objectives of the agricultural and scientific communities are not always congruous, they need not be incompatible (Report, 1972, p. 13). In fact in the long run, it would be expected that the objectives of these two client groups would converge. But Lowell Harden points out that "...clientele support and colleague approval are often measured on different yardsticks." He goes on to caution his professional peers (in this case, agricultural economists) that while "...our ears are well tuned to the voices of academic colleagues...we need also to listen to our discerning clientele" (Harden, 1963, p. 939). But the problem is much more serious in the LDC's. In fact the problem is two fold.

The primary problem is the dominant orientation of research workers to the professional peer group to the neglect of the agricultural community. The question, therefore, is how to establish

and/or strengthen the research worker's orientation to the agricultural community to balance his already strong professional orientation.

A second problem is how to establish and strengthen a different professional orientation in LDC's which focuses, in general, on the problems of poor nations and specifically on solving agricultural production problems.

Certainly the international research centers can and are having an influence on these orientations. Therefore, one aspect of this study will be to determine how each center views these problems and then to examine if and to what extent each center is influencing the behavior of its former participants.

Reward Systems for Agricultural Research Workers

In discussing the development of transplanted agricultural research institutions in LDC's, it was mentioned that as professionally oriented research workers take over the leadership of research institutions, it would be expected that they would make policy changes concerning research goals and activities that are consistent with their own professional orientation. To implement these new "working rules," it would be expected that a different reward system would also emerge within these institutions, which would reflect and support these new goals and activities.

Since reward systems can differ within research institutio and since these reward systems tend to reflect and support the type of research worker behavior being valued by these institutions, it

appears useful to digress briefly and consider the types of reward systems used within the research structure of the United States. Given this information and perspective, it is possible to suggest how an external organization, such as an international research center, might indirectly reward certain types of research behavior within a national institution.

The Reward Systems for Agricultural Research Workers in the U.S.

As mentioned earlier, the agricultural research system in the U.S. is made up of two major components: the public and the private sectors. The Colleges of Agriculture in each state, with their network of experiment stations, cooperate closely with the USDA to make up the public component. Less visible, yet larger in terms of total research expenditure, is the private research establishment, concentrated mainly in the agricultural supply and processing industries (Wilcke & Sprague, p. 3).

The private food and agricultural industry is primarily interested in developing products and services which can be sold to agricultural producers and consumers. This market orientation of private industry greatly influences and directs the type of research undertaken. Because private industry conducts product-oriented research, it seems clear that a research worker who joins private industry makes a decision (either implicitly or explicitly) as to the type of research career he will follow. While he may maintain contact with the professional association, his primary purpose vis-a-vis his professional peer group is to

keep abreast of the latest theoretical breakthroughs in his field of specialization. Generally he is not a contributing member to the growing "body of knowledge" in his field of study. Therefore the principal reward for following a research career in private industry is monetary and after several years with a company it is common to hear the remark, "I can't afford to leave."

In the public agricultural research sector much of the knowledge-generating research is carried on at the college of agriculture (i.e., the main experiment station within each state) and is generally closely connected with the academic departments of the college. Rewards and sanctions are primarily left to the individual departments; so, each scientist is evaluated by his professional peers. Furthermore, to avoid the problems of subjective evaluations, the trend has been to use a faculty member's publication record as "objective data" to evaluate his productivity (a quantitative measure) and competence (a qualitative measure as judged by which scientific journals and which professional associations accept his papers).[6] A more recently developed evaluation tool is the scientist's citation record. Frequency of citation (by other scientists in the field) is taken

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[6]The Research Newsletter of the College of Agricultural and Life Sciences, University of Wisconsin--Madison, reports that the college "...ranks FIRST in the number of total papers published in scientific journals and FIRST in the number of publications per researcher of all U.S. land grant institutions.... The Research Division congratulates each staff member in the College for outstanding academic excellence and--'let's forge ahead in the seventies'" ("Research," Volume 10, Newsletter Number 4, November, 1973).

as a combined measure of (1) the current relevance of the scientist's research to the field of study, (2) his productivity in contributing to the body of knowledge, and (3) his professional competence as judged by his professional peers. The granting of tenure and salary increases are largely based on these types of criteria. Therefore research scientists who desire to gain tenure and move up within the department; and eventually to move to a more prestigious department in another university must conduct research activities in accordance with these professional working rules.

The output of applied research in agriculture is much more differentiated than that found in knowledge-generating research. While much of the output of technology-developing research would be in the form of messages to the agricultural community (for example, a fertilizer or pesticide recommendation), the output could also be in the form of new genetic technology (i.e., an improved crop variety), mechanical technology (i.e., a new type of harvester), or even a substantially new type of production system (i.e., minimum tillage). The problem is obvious. There is no easy method for the comparative evaluation of the output of technology-developing research workers because both the type of output and payoff time for that output may differ greatly between and even within fields of specialization.

Given these difficulties in evaluating the output of applied research, the reward system for this type of research may differ substantially from the system used in knowledge-generating types of research organizations. Without objective criteria with which

to measure a research worker's performance, other factors such as seniority, years of service, and subjective criteria may become the important factors in deciding when salary increases and promotions are given. While merit or research productivity can be assessed within research institutions of this type, because of the difficulty in making comparable measures of performance objectively, the organizational or administrative tendency is to look for other types of criteria that will minimize reward conflicts among staff members and between the technical staff and administrative officers.

Since technology developing research workers are more commonly located at branch research stations (away from the intellectual community) and generally concentrate on more practical, field-oriented research, these jobs generally have lower professional status and pay than their colleagues at the college of agriculture. The research workers who carry out this type of research work are often in these positions because they prefer such work, because they lack the ability to compete with their academic colleagues, or because they are blocked from advancement. Whatever the reason, these jobs continue to lack the professional rewards and status afforded to those scientists conducting knowledge-generating research. Therefore if a research worker is content to stay in the public research sector, where salaries are traditionally lower than those offered in the private sector, most will do so because of the intellectual and scientific challenges associated with conducting theoretical research or knowledge-

generating research.

The Incompatability of the U.S. Reward System for Agricultural Research Institutions in LDC's

In most LDC's the agricultural research function is confined to the public sector. Agricultural supply industries are just beginning to develop and are not equipped to take on the technology developing research function. In the short run, most agricultural research will be conducted in the public sector.

The formal reward and advancement system within governmental research institutions in LDC's is generally based on some type o objective criteria, such as level of education, seniority, years in service, level of position, etc. Where research performance is a basis for advancement and promotion, there is a strong likelyhood that LDC's will copy the reward system used in industrially developed countries tending to reward knowledge-generating research. But while the direct transfer of a knowledge-generating reward system into national research institutions in LDC's will be some time in coming (because of the lack of national professional associations and scientific journals in most LDC's) it still appears that the normative structure which this reward system represents has been widely accepted by individual scientists.

Given a working environment where performance and achievement are not easily measured in the formal reward system, motivated and independent (autonomous) scientists will likely look to external sources or groups for their personal

rewards, status, and satisfaction. Given the low status of agriculture in most LDC's and the scientist's exposure to the professional group during his graduate training in a foreign university, it is likely that most research scientists will want to continue working in their field of specialization, building on their previous research work hoping to have a research paper accepted by an international journal in their field of study.[7]

The problem for the research institution, then, is how to get research workers committed to technology development types of research aimed at helping agricultural producers if there are no professional rewards or monetary incentives for this type of research, particularly if a scientist can gain international recognition from his professional peers by contributing to the body of knowledge in his field. But, as pointed out earlier, contributing to the body of knowledge in the industrially developed countries assumes accepting the frontiers of knowledge as defined by these countries. These research activities may have little relevance to the agricultural problems of local producers.

The question to be examined later in this study is how do IRRI and CIMMYT view this apparent normative problem among agricultural scientists and institutions in LDC's and what steps, if any, are they taking to influence the existing normative structure of these institutions? The indirect intervention by an

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[7] This is exactly the problem Hans Singer refers to in his paper on Technological Dualism.

international center into the normative structure of a national program could be accomplished through an externally developed, prestigious reward system that would be both accessible and useful (perhaps even limited to) to research workers in LDC's. Examples of such structures within an external reward system are: (1) creating a new research publication that would accept research papers dealing with specific types of research problems, (2) holding international workshops, for example, on technology development problems and only inviting participants actively conducting research in that area, (3) systematic visits by center staff members to those research workers and programs conducting specific types of research--possibly giving or arranging direct assistance (equipment, etc.), (4) an international awards program (perhaps with a sabbatical year at the center) for research workers from national programs making significant contributions to the improvement of agriculture.

In summary, it would appear that the inappropriate research orientation that apparently exists in many national research systems in LDC's may have resulted from the impact and continuing influence of the professional groups (representing different fields of study) within rich nations. The influence of these professional groups on the scientists of LDC's has resulted in, first, the internalization of these professional values by the individual scientists and later to the adoption of this normative structure as the working rules of those research institutions.

If the assumption is made that the international centers have a role to play in reorienting the focus of these national

research institutions--which this particular study does assume--then the problem faced is twofold: (1) how to redirect this professional orientation to problems relevant to the poor nations and (2) how to balance this more relevant professional orientation with a strong concern for solving the production problems of local agricultural producers. How each center handles these problems will be examined later.

CHAPTER II

TRAINING AGRICULTURAL RESEARCH AND EXTENSION WORKERS

Introduction

In the last chapter, the problem of ineffective research and extension organizations in LDC's was examined. It was hypothesized that the failure of national research systems to develop a continuing flow of improved technology was due to an inappropriate research orientation which emphasized knowledge-generating types of research. To help understand the research, development, and extension process, a functional model was developed, so that this process can be viewed in terms of several interrelated steps. This functional model was then related to the effective agricultural research system in the United States to determine the levels of emphasis that seem appropriate for the different research functions.

The functional model of the research, development and extension process describes the major jobs or tasks that must be carried out if this process is to operate successfully. With a series of jobs or tasks to be carried out, it is possible to identify the types of technical manpower that will be needed to accomplish this overall process. This in turn, suggests the

technical skill areas to be focused on within a training strategy.

In this chapter, the focus is shifted to the training process itself. The first part will be devoted to some of the more general and theoretical aspects of the training process. After clarifying some definitional questions, a simple model of the training process will be presented. Next the objectives of the training process (behavioral and organizational change) will be discussed and related to specific types of training objectives. Since the training programs being studied in this research focus on different types and combinations of training objectives, a taxonomy of educational objectives will be introduced and summarized briefly. Next the steps or stages in the training process will be discussed and this will be followed by a brief description of different types of training methodologies that are directly relevant to this study.

The second section will deal with the current state of knowledge about training agricultural research and extension workers. Generally this section focuses on the problems associated with training agricultural personnel from LDC's, with particular reference to training in foreign educational institutions.

In-Service Training and Educational Programs

This study is concerned with the training and education of research and extension workers who come from and return to their respective national agricultural institutions. They come to increase their technical knowledge and skills; and, when they return to their home institutions, they are expected to use these

skills and knowledge to become more effective in their work. Because the learning process is viewed in the context of a continuing work responsibility within a national agricultural institution, all three programs included in this study are considered to be a type of in-service training or education.

Education and training are terms which convey different meanings to different people. Generally it is unnecessary to carefully differentiate between these two terms; however, in this study, due to the conclusions that will be made concerning the influence of training on the behavior of former participants, such definitional questions must be resolved here.

The American Society for Training and Development (ASTD) in its book Training Methods for Skills Acquisition defines training as the "Process of effecting change in an individual human's behavior... often applied to the acquisition of limited, job related skills" (American, 1972, p. 8). Lynton and Pareek have this to say about training: "Training as we see it aims at a lasting improvement 'on the job'. The kind of education we call training...is in truth 'not for knowing more but for behaving differently'. Training then is concerned with people-on-jobs-in-organizations..." (Lynton, 1967, p. viii). Finally Staley considers training "...instruction and learning concerned with good performance of a specific task or a set of tasks making up a job or occupation" (Staley, 1971, p. 10).

Education, on the other hand, can be described as the process of learning new knowledge and "acquiring orderly, logical systems for processing new information" (American, 1972, p. 8). Staley

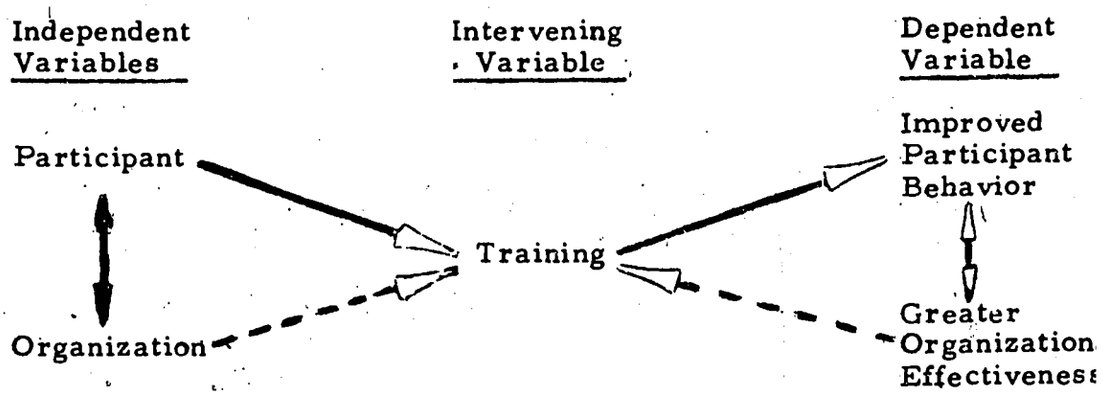
defines education in an occupational context: "Education means instruction and learning broadly relevant to performance in all or a considerable number of occupational roles..." (Staley, 1971, p. 10).

The IRRI Research Fellow-Scholar Program may not be clear in this context because it can be viewed as both in-service education and training. In particular, many of the IRRI research scholars take M.S. degrees during their tenure at IRRI, strongly suggesting a clear-cut educational program. While this is true, the focal point of the scholar's research project is generally a specific production problem that he will work on once back home. Furthermore, while IRRI provides the stipend and tuition for scholars pursuing degree programs at the University of the Philippines College of Agriculture (UPCA), IRRI's direct input into the scholar's program primarily concerns the research project(s) carried out within IRRI's research facilities under the direction of an IRRI senior scientist. Therefore, while the IRRI Research Scholar Program is technically an educational program, because of the in-service nature of the overall program, the problem-specific focus of the research training, and finally the fact that fellows and scholars are expected to continue working on these problems after returning home, this program like the others, will be viewed as technical training programs.

The Training Process

Training will be considered in this study as an intervening variable in the process of improving the effectiveness of both agricultural research and extension workers and their respective work organizations. Lynton and Pareek have developed a simple model of the training process, which will help clarify how training is understood in this study.

FIGURE II-1: A Model Depicting The Role of Training In Behavioral and Organizational Change



Source: Lynton, R. P. and Pareek, Udai, Training for Development, Richard D. Irwin, Inc. and the Dorsey Press, 1967, p. 18.

As Lynton and Pareek point out, however, in reality this process becomes more complex, with feedback processes being developed between the work organization and the training institution to further improve the training process for future trainees. This simple model, however, serves the immediate purpose by identifying the key components of the training process--particularly the dependent variables. The next step will focus on these dependent variables

as a means of determining the objectives of training.

The Objectives of Training: Behavioral and Organizational Change

Behavioral change on the job means that agricultural workers act differently in such a way that results in an improved performance of that job. Training objectives are derived directly from those behavioral patterns that are associated with the improved performance. To establish the specific objectives of training as they apply to behavioral change, it is necessary to fully understand the type of job to be completed. One way to do this is to begin by completing a task analysis. Generally this includes listing or identifying all of the sequential steps necessary to complete the job successfully. The next step is to define precisely how each task is to be performed and finally to set specific criteria or standards to determine when the desired level of performance has been achieved (American, 1972, p. 40).

Behavioral change can be brought about through the training process by changes in three factors: (1) changes in skills--knowing how to do a particular task; (2) changes in knowledge--knowing how something works because of an understanding of the relevant concepts, principles, and facts; and (3) changes in attitudes--the way an individual feels about a particular activity or environment (Warren, 1969, pp. 8-9). Since all three of these factors are complex and directly influence the participant's performance on the job, they will be considered in more detail as educational objectives in the next section.

Organizational Change: Training programs are frequently used by organizations to maintain existing functions by providing the necessary skill training for employees. In this study the concern is with improving weak or ineffective agricultural institutions in LDC's. For this reason, the training of individuals or groups of trainees can be viewed explicitly as a means of bringing about organizational change.

The logic of establishing specific objectives of training as they apply to organizational change is much the same as that used in determining behavioral objectives. First it is necessary to establish the over-all organizational objective of the research, development, and extension process--which is to produce and make available a continuing flow of improved technology to agricultural producers. Next it is necessary to fully understand the total process involved in producing and making available this technology. This involves completing a functional analysis, such as was done in the first chapter, to determine the sequential steps necessary to successfully complete the process. Finally it is necessary to define, as precisely as possible, how each function is to be performed and to establish certain criteria or standards for each function--so that it is possible to determine when the desired level of performance has been reached.

An organizational change strategy requires "...the closest collaboration between the training institution and the work organization. The institution acts in a consulting role prior to executing the core parts of the required training and often again after

participants return to their jobs" (Lynton, 1967, p. 46). Lynton and Pareek go on to summarize the necessary steps involved in implementing this joint approach to organizational change:

> As a starting point, this strategy addresses the question what does the organization need to learn to achieve a particular change. The next step is to assess the training needs in detail and relate them to other requirements of change. The organization then uses training to ensure competent staff is available in such numbers, at levels and at times that the change can be accomplished. This strategy directly guides the selection of individuals for training and for jobs upon their return (Lynton, 1967,, p. 46).

The purpose of the foregoing section has been to establish a logical structure by which the objectives of training can be tied to behavioral and organizational objectives. Later, when the three specific training programs are discussed, this logical structure will be used to relate training objectives to the specific tasks (and functions) that participants (and organizations) are expected to carry out. As will become obvious from the description of these respective training programs, the training objectives differ from job to job and from function to function. In fact, if training programs are presumed to have a considerable influence on the work behavior of a participant, a close examination of the training objectives can describe the intended behavior of the participant once back home on the job (Bloom, 1956, p. 12). Since these training objectives appear to be very important to an analysis of these respective training programs, and since they differ greatly in type and level of complexity, the discussion will digress here briefly so that the taxonomy of educational objectives can be

summarized. This taxonomy will provide a useful framework for discussing and analyzing the training objectives of each program later in the study.

A Taxonomy of Educational Objectives[1]

A major research undertaking in the 1950's and 1960's resulted in the Taxonomy of Educational Objectives. The first handbook, which was published in 1956, dealt with the cognitive domain and the second handbook, which was published in 1964, dealt with the affective domain. The third domain--the psychomotor--was never developed since academic institutions have so seldom taught in this area that the authors did not believe a useful classification could be developed.

The Cognitive Domain

The taxonomy within the cognitive domain focuses on "intended behaviors" that result from the pursuit of different types of educational objectives. In particular, these objectives are classified in a hierarchical order based on increasing complexity, with the assumption being that "...each classification within it demands the skills and abilities which are lower in the classification order" (Bloom, 1956, p. 120). Furthermore, there is

[1]The context of this section has been largely drawn from the Taxonomy of Educational Objectives, Handbook I: Cognitive Domain and Handbook II: Affective Domain, by Bloom, B.S. et al; as well as H. C. Kelman's "Compliance, Identification and Internalization, Three Processes of Attitudinal Change" in Journal of Conflict Resolution, Vol. 2, 1958, pp. 51-60.

evidence to suggest that the more complex objectives are more difficult to learn than the simpler objectives (Bloom, 1964, pp. 8-12).

The terminology used in the taxonomy of cognitive objectives is descriptive and generally self-explanatory; therefore, an outline of these objectives will first be presented and this will be followed by a brief explanation of each type of objective, including an example or two directly relevant to this study (Bloom, 1956, pp. 201-07):

Taxonomy of Cognitive Objectives:

I. Knowledge:

- A. Knowledge of Specifics
  1. Knowledge of Terminology
  2. Knowledge of Specific Facts
- B. Knowledge of Ways and Means of Dealing with Specifics
  1. Knowledge of Conventions
  2. Knowledge of Trends and Sequences
  3. Knowledge of Classifications and Categories
  4. Knowledge of Criteria
  5. Knowledge of Methodology
- C. Knowledge of the Universals and Abstractions in a Field
  1. Knowledge of Principles and Generalizations
  2. Knowledge of Theories and Structures

II. Comprehension

- A. Translation
- B. Interpretation
- C. Extrapolation

III. Application

IV. Analysis:

A. Analysis of Elements

B. Analysis of Relationships

C. Analysis of Organizational Principles

V. Synthesis:

A. Production of a Unique Communication

B. Production of a Plan, or Proposed Set of Operations

C. Derivation of a Set of Abstract Relations

VI. Evaluation:

A. Judgements in Terms of Internal Evidence

B. Judgements in Terms of External Criteria

The intended behavior associated with knowledge, as an educational objective, concerns the ability of an individual to repeat, quote or recall certain specifics, universals, methods, processes, patterns, structures and/or settings. For example, a trainee might be expected to know what type or amount of pesticide to use in case of a specific problem (e.g., insect infestation); or, he might be required to know a specific research method involved in carrying out a fertilizer trial on wheat; or, he might be expected to know basic genetic principles associated with viral disease resistence in rice.

Comprehension, as an educational objective, represents the lowest level of understanding of knowledge and generally means that the individual knows what is being communicated and can put the material or idea into his own words.

Application represents the next level of understanding and means that the individual can apply the idea or material by giving examples, by identifying a particular use of the concept, etc.

Analysis, as an educational objective, means that the individual can break down a communication or problem into its constituent elements and identify the relationships between these elements. Experimental research that expands the frontiers of knowledge is largely a product of a continuing process of analysis (and verification).

Synthesis involves a process of putting together, combining or recombining discrete elements so as to form a complete, integrated newly conceived whole. This type of process would be associated with the task of genetic improvement, whereby a research worker attempts to bring together many different types of desirable characteristics into a new improved variety; or could involve the development of a new "package of practices" involving different types of biological and physical inputs, cultural practices, etc., for a particular environmental region.

Evaluation, as an educational objective, involves decision-making or making judgements about a particular material or method based on certain types of criteria. For example a plant breeder should be able to select advanced lines on the basis of objective criteria and systematically decide which materials should be carried forward to the next generation, released as a new variety or discarded from the program. Likewise a production agronomist or production team should be able to arrive at specific

recommendations, to make up a new "package of practices," based on experimental results and taking into consideration the availability and cost of inputs, product prices, production targets, etc.

The Affective Domain

The taxonomy of affective objectives developed by Bloom and associates views different types of affective objectives along a continuum as was the case in the cognitive domain. In this case, however, the criteria for differentiation is not complexity, but increasing levels of internalization. In fact, the theoretical framework developed in this taxonomy goes well beyond the needs of this study in defining and categorizing different types of affective objectives, since the training programs are at most concerned with the professional values of agricultural workers vis-a-vis certain types of research activities--not with changing the entire value system of the trainee. For this reason, a related, but simpler conceptual framework has been selected for use in differentiating between different types of affective objectives.

H. C. Kelman differentiated attitudinal change into three distinct processes: compliance, identification, and internalization. In addition he related these changes to different types of power that could be used by the influencing agent to achieve a particular behavioral objective. The three processes of attitudinal change are defined as follows:

> Compliance can be said to occur when an individual accepts influence because he hopes to achieve a favorable reaction from another person or group. He adopts the induced behavior not because he

> believes in its content but because he expects to gain specific rewards or approval and avoid specific punishments or disapproval by conforming.... When an individual adopts an induced response through compliance, he tends to perform it only under conditions of surveillance by the influencing agent.
>
> Identification can be said to occur when an individual accepts influence because he wants to establish or maintain a satisfying self-defining relationship to another person or a group.... The individual actually believes in the responses which he adopts through identification, but their specific content is more or less irrelevant. He adopts the induced behavior because it is associated with the desired relationship.... When an individual adopts an induced response through identification, he tends to perform it only under conditions of salience of his relationship to the agent.
>
> Internalization can be said to occur when an individual accepts influence because the content of the induced behavior--the ideas and actions of which it is composed is intrinsically rewarding.... He may consider it useful for the solution of a problem or find it congenial to his needs. Behavior adopted in this fashion tends to be integrated with the individual's existing values.... When an individual adopts an induced response through internalization, he tends to perform it under conditions of relevance of the issue, regardless of surveillance or salience (Kelman, 1958, pp. 53-54).

While Kelman's processes for attitudinal change represent different means of achieving a particular type of induced behavior, these processes can also be viewed as different levels of commitment in the overall process of internalizing a value or value set. It is this particular perspective that will be used in this study so that induced behavior can be categorized both in terms of the relationship of the individual with the influencing agent, but also in terms of different levels of commitment in the process of achieving particular (affective) educational objectives.

The following example will demonstrate how this theoretical framework will be operationalized. If the desired behavior occurs at the training site, but does not continue once the trainee returns home, then (if such behavior is possible with the job assignment) it will be assumed that compliance was the process or level of attitudinal-change achieved. If the induced behavior continues on the job as long as there is an active follow-up program between the international center and the trainee, but then lapses when such follow-up programs terminate, then identification was the process or level achieved. Finally if the induced behavior continues even after follow-up programs with the trainee have ceased, then it will be assumed that the internalization of the value or value set will have occurred.

Types and Methods of Training Relevant to This Study

Training methodologies are selected for use on the basis of a number of factors, but most important are resource availability (staff, facilities, etc.) and the behavioral objective being sought. This section will be used to introduce, describe, and define the different types and general methods of training that are relevant to the programs included in this study.

Skill training categories that are described in the literature are generally taken from business and industry where the majority of skill training occurs. Inasmuch as the training of research and extension workers is somewhat different than these types of training programs, it will be necessary to adapt existing terms

and definitions to meet the needs of this study, or where necessary to create new terms and definitions.

An adaptation of on-the-job training is employed by CIMMYT in carrying out the practical skill training portion of its wheat breeding, wheat pathology, and cereal technology training programs. The training takes place within the actual working environment of an ongoing research program--but it's CIMMYT's program in Mexico and not the working environment of the national program. Other than this difference, the training procedure is basically the same. The American Society for Training and Development (ASTD) has summarized the processes involved in on-the-job training (OJT):

> In OJT, both the trainee and the instructor operate in the actual job environment. The trainer is a qualified and experienced worker who has been selected not only for his skills as a worker but also for his ability to teach those skills to someone unfamiliar with the job. He first explains the process or operation involved to the trainee. The trainee then observes the experienced employee carry out the process. After hearing the explanation and observing the work performed, the trainee does the task himself under the guidance of the trainer. The trainee receives whatever correction and advice are necessary and continues to do the task under observation until both he and the trainer consider that he has mastered it. At this point the trainee begins to learn the next task or process until he masters all elements of the job. At this point training ends and the trainee is expected to be fully productive (American, 1972, pp. 22-23).

While on-the-job training has been criticized (see CIMMYT, 1972, pp. 19-20) because production objectives sometimes appear to outweigh training objectives, this methodology has some distinct advantages. In particular it allows the trainee to operate in a realistic working environment rather than in a training environment.

While this difference may be insignificant to an assembly line worker who performs a routine job in a controlled working environment, research and extension workers frequently operate with considerable freedom and latitude vis-a-vis the type and amount of work performed. On-the-job training can provide the trainee with a realistic idea as to how an effective research or extension program should operate and how the various tasks and functions are actually integrated into an on-going program.

The IRRI Rice Production Training Program (RPTP) employs an adaptation of vestibule training whereby the on-the-job situation is duplicated off line in so far as possible. In the case of the RPTP, the applied research trials, extension demonstration plots, the practice training course, etc., are all conducted within IRRI's facilities, but on land and in buildings set aside for these particular training functions. Since the term vestibule training comes from industrial training programs and is not descriptive of this type of training, the term field practice training will be substituted for it. The process involved, however, is largely the same and is summarized as follows:

> Vestibule training is intended to gain all of the benefits of on-the-job training with few of its shortcomings. In Vestibule training, the on-the-job situation, the production system itself, is duplicated off-line. A separate area is set up in which the actual production processes can be carried out. What is lacking is the production requirement of the on-line situation...
>
> In Vestibule training the instructor assigned to do the training has this assignment as his primary task. Training is not something he does in addition to his other duties, as is true in the actual production

> situation of OJT, where the instructor is frequently required to maintain production as well as train the new employee.
>
> The Vestibule "School" approximates as closely as possible the actual production situation in terms of processes and equipment used. The method makes heavy use of simulation techniques. The basic difference between Vestibule methods and OJT is that in Vestibule training, the primary aim is learning--production is not normally attempted as one of the outputs (American, 1972, pp. 24-25).

The final type of training program being considered in this study is being termed "Research project training." This type of training is commonly used in the IRRI Research Fellow and Scholar Training Program and is used to prepare individual research workers to carry on experimental (original) research in a particular problem area of a field of study. Generally this type of training can be equated with technical research training at the graduate and post-graduate levels within academic institutions.

Since experimental research is highly specialized in both method and content, it is nearly impossible to develop a common training format that would be appropriate for more than a few trainees at a time. For this reason organized training programs for this type of research worker are uncommon and a tutorial training methodology is generally used.

Experimental research trainees can focus on either subject matter (knowledge and theory); research methods, skills and techniques; or a balance between the two--depending on the breadth and level of their development. Frequently, however, skill training is more incidental to the total learning process since trainees must

learn certain skills and techniques in order to carry out a particular type of experiment. As types of experiments change, new skills may be required by the research worker. He must learn to use new research techniques as the need arises. Particularly in the case of inexperienced research workers, the main objective of project training would be to provide the trainee with a positive research experience studying a relevant problem.

All three training programs use a variety of other training methods, but most common would be some form of classroom instruction (lecture, seminar, discussion, etc.). In this case the emphasis is generally on some type of cognitive objective, rather than on (psychomotor) skill training. In fact, as will be discussed latter, the Rice Production Training Program spends approximately one-half of the training course in classroom instruction emphasizing cognitive objectives relating to modern rice technology and production. Much of this classroom instruction is then related to the practical skill training that occurs in the field. Since these other types of training are less important to the general skill training focus of this research, they will not be discussed in detail here, but will be described as the need arises within the specific sections dealing with training methods of the respective programs.

The Stages of Training[2]

The training process can be broken down into three general

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[2] Adapted from Lynton, R. P. and Udai Pareek, Training for Development (Homewood, Ill.: Richard D. Irwin, Inc.), pp. 19-27.

stages: (1) pre-training, (2) training and (3) post-training.

Pre-training: For the potential trainee, this is the stage when he becomes aware of a potential training experience; when he weighs the opportunities and problems (both personal and career) associated with such an experience and then comes to a decision that he should apply for the program. Later, if accepted, he again must decide to accept the training invitation and if affirmative, make the necessary arrangements and preparations for departure.

For the work organization, the pre-training period may take two different directions. It may be aware of the up-coming program and recognizing the need for this type of skill training for its staff initiate the application and selection procedures within the organization. In this case the work organization will likely play an active role in selecting appropriate individuals for the training program. In a second case, an individual staff member may initiate the process and apply directly to the training institution. In this case, if the applicant is selected, the work organization would need to make a reactive decision whether the training would be appropriate vis-a-vis the goals and operations of the organization and whether or not the organization could afford the absence of the particular staff member.

For the training institution this is the period of informing cooperating organizations and potential trainees of up-coming training opportunities and then working with these organizations in screening and selecting the best candidates to be invited for the training program.

Training: The actual training period is when the training institution provides trainees with appropriate learning opportunities. The different types of training objectives and methodologies that are relevant to this study have already been discussed in the preceding sections of this chapter. The actual subject matter, specific objectives and methodologies of each training program will be discussed in detail in the following chapters on the respective training programs themselves.

Post-Training: This is the period when the returning trainee attempts to utilize the training he has received on the job. As Lynton and Pareek point out, "In the final analysis, training is successful if the participant's effectiveness at this job goes up as expected. Other preconditions, such as adequate equipment, basic attitudes of colleagues, and organizational policy, have to line up with the change. Discrepancies mean that the participant gets frustrated at the very end, that is, when his expectations are at their highest" (Lynton, 1967, p. 22).

The training institution can also play an important role in supporting the new behavior, after the formal training program has ended. Particularly in many LDC's, resources available to many research and extension organizations are very limited. In some cases, the training institution can anticipate or respond to small, but very important requests from returnees. Likewise in agricultural research and extension, new findings and developments are continuous and it is important that former participants are kept up-to-date. This may also serve to reinforce the new behavior

patterns, if the participant feels the training institution is interested in his continuing success.

TRAINING PROGRAMS IN AGRICULTURE

Training and Educational Programs for Agriculturists in the United States

In searching the literature on training agricultural research and extension workers in the United States, there is an apparent absence of any research or other writings that deal directly with this subject or problem area. While little is said about the preparation of agricultural workers for jobs in research and extension, it is obvious that this function is of great importance in the United States, given the well developed and financed colleges of agriculture in each state. But while considerable effort is given to the advance training of agricultural workers in this country, it may be instructive to briefly review the distinctions made earlier between training and education. Education, as Staley defined it, is broadly relevant to the performance of a considerable number of occupational roles, while training is concerned with a specific set of tasks making up a job (Staley, p. 10). Given these definitions, it is clear that colleges of agriculture generally emphasize educational rather than training objectives.

The university graduate in agriculture (particularly at the B.S. and M.S. levels), by and large, is not prepared for a specific job, but has some flexibility regarding the type of job(s) he may choose to undertake. (At the more advanced levels--Ph.D. and

post-doctoral--this flexibility decreases as specialization increases.) New graduates enter the job market with an understanding of the relevant theories (logical systems) in their field of study, but with few of the job related skills and techniques they will need for the actual assignment they will eventually undertake. The question is asked, where do they acquire the skills and techniques they will need to function effectively in these job assignments? Like most inexperienced workers, regardless of their field, these research and extension workers generally undergo a period of informal, unstructured on-the-job training. To help visualize how this on-the-job training might occur, the following descriptive statement may be useful.

The newly hired, junior level research or extension worker will generally be assigned to work with an experienced, senior level staff member to learn the specifics of the job. Because the training relationship is among professionals, it will seldom be explicitly termed a training or apprenticeship type of relationship. Yet this is largely what it is. As the junior level staff members gets more experience and confidence, he will begin to function more and more on his own. Slowly the student-teacher type of relationship changes to one of professional colleagues consulting with one another on common problems.

There are two very basic factors that make this type of training effective to the work organization. First, the organization knows what function the new staff member is to carry out and how it fits into the total operation of the organization. Second, there

is sufficient staff time and expertise available, particularly from a skills and methods standpoint, for the new staff member to learn the specific work function he has been hired to carry out. If the latter element is not present, then an experienced research or extension worker will need to be hired (who already knows the necessary skills and methods to set up a functioning program).

The premise which has been developed here is that within an effectively operating agricultural research and extension system, considerable on-the-job training occurs--frequently through informal unstructured professional relationships--thereby insuring that (1) the necessary work functions are properly carried out by new personnel, and (2) that the goals of the organization are achieved. In a situation where organizational goals are unclear or in dispute, where organizational functions are not clearly defined and where experienced personnel are unavailable, the recent university graduate (regardless of where he comes from) would certainly be faced with a perplexing task in trying to determine how he might best proceed. What is suggested is that this may be the type of organizational environment that many returning foreign students face on their return home from academic programs abroad.

A Review of Past Experience in Training and Educating Agricultural Workers from LDC's in Academic Programs in the United States

The experience of training and educating foreign agricultural workers in the United States during the past two decades appears to have been beset by numerous problems.

These problems and deficiencies can be classified into two general types: (1) those characteristics associated with foreign agricultural students as a group, and (2) those institutional characteristics associated with advanced degree programs in the U.S. that make such programs less than appropriate for foreign students from LDC's. This review will begin by examining those characteristics of foreign agricultural students that are judged as being problematic.

As a starting point, there appears to be wide agreement that the majority of foreign agricultural students studying in the U.S. come from urban, rather than rural backgrounds (for example see: Wharton, 1959, p. 33, Mellor, 1963, p. 227 and Darrah, 1959, p. 1383). "The basic cause of this situation," as Mellor points out, "lies with a history of inadequate rural school systems, with the result that acquiring a secondary school education and the college education for which it is requisite requires urban living. Historically, even the village boy who has become educated has managed it only by moving to live with relatives in town. As a result he has become urban oriented and experienced" (Mellor, 1963, p. 227).

This lack of a rural background apparently results in a number of related consequences. One major problem is that many foreign students have a general lack of understanding about the agriculture of their own countries and about production agriculture in particular (see: Lewis, 1959, p. 6; Wharton, 1959, p. 40; Castillo, 1968, p. 239). Mellor summarizes the problem clearly: "The problem of the foreign student is less one of not knowing American agriculture than one of not knowing any operating

agriculture at all" (Mellor, 1963, p. 228).

The lack of a rural background and knowledge of production agriculture must have considerable influence on the attitudes and motivations of agricultural workers. The obvious question is why do these types of individuals enter agricultural institutions in the first place. Both Mellor and Wharton point out that it is common for students to prefer careers in the professions, such as law, medicine, or engineering to one in agriculture, but "find that the competition excludes him from his first choices" (Mellor, 1963, p. 227).

The viewpoint of agriculture as a second-rate occupation poses serious selection problems for foreign training and education programs. As Wharton sees it, "Students from urban areas and without farm backgrounds are not automatically or inherently unsympathetic toward rural people and problems...However it must be recognized that finding urban youth who are interested and capable, and who also seek a career in agriculture is extremely difficult" (Wharton, 1959, p. 34).

The motivational problem vis-a-vis service to rural people is also frequently mentioned as a serious problem among foreign agricultural students (again see: Mellor, 1963, p. 227, and Wharton, 1959, pp. 36-38). Lewis, in discussing this problem among foreign graduate students in agricultural economics states that these students "...do not hold their own peasant farmers in respect...Many of them cannot communicate with farmers. They will not listen to farmers and have no common ground of

understanding with them" (Lewis, 1959, p. 5). Wharton found in a survey of professors in the U.S. that they "...feel strongly that there is a need to send students for (United States) training who have a greater desire to serve their own agriculture. These persons say that the present levels of development in underdeveloped areas make it necessary to concentrate greatest attention on those individuals with service-oriented motivations" (Wharton, 1959, p. 37).

Since the backgrounds and attitudes of many foreign agricultural students are viewed as serious limiting factors to the future effectiveness of these individuals as agricultural research and extension workers, it will be useful to follow this discussion a step further and see what type of consequences result, regarding the type of research they prefer to undertake. C. P. McMeekan thinks that foreign-trained agriculturists "...return home with outlocks and techniques much too advanced for their countries' needs. ...They absorb a philosophy of modern science that attaches more merit to publication in a scientific journal to enhance their specialist reputation than to the dignity of immediately useful but unpublishable work. It is difficult to induce these young specialists to take on such mundane jobs as the testing of different cultivation practices..." (McMeekan, 1965, p. 72). Mellor also thinks that many students prefer theoretical rather than applied research. He finds many students working under the dubious assumption that "Work with basic theory is thought to be possible without an operating knowledge of agriculture" (Mellor, 1963, p. 228). One view expressed in the Wharton study is that "...the Asian culture generally

places a high premium on theoretical subjects, abstract logic, and tl more esoteric academic subjects. Consequently the courses which Asian students insist upon taking and the orientation of their dissertations are along lines which many professors consider to be of little practical value in resolving the problems of farmers in underdeveloped countries (Wharton, 1959, p. 37). While these are some of the potential problems that agriculturists from LDC's may bring with them to the training or educational institution, the problems are not all one-sided.

One of the more serious institutional constraints that directly influences the type of training foreign students receive in U.S. universities is the continuing movement toward increasing specialization within disciplines. The problem is that advanced graduate programs require original research studies as part of the degree requirement. As the frontiers of knowledge continue to expand, this results in many U.S. trained foreign students focusing on more and more specialized problems. The results of this type of training are agricultural scientists who know "more and more of less and less." Yet when they return home they find themselves in positions where "They are expected to know a great deal more than they have studied" (Wharton, 1959, p. 30).

Another aspect of the specialization problem, is the appropriateness of research problems studied by foreign students while in the United States (see Lewis, 1959, pp. 4-5 and Castillo, 1968, pp. 238-39). Most obvious in agriculture is the differences between doing research in temperate vs tropical climatic

environments. Less obvious, yet important, are differences in conditions such as: small subsistence versus large commercial types of agricultural production; and "growing the same crops under conditions of affluence and sophistication versus that of producing under conditions of crude facilities and scarce resources (Castillo, 1968, p. 239).

A final problem is the research techniques and methodologies being taught in U.S. universities. As Mosher once commented about Asian agricultural economists: "In some cases... students from Asia after their return are called upon to tackle problems for which the appropriate methodologies are those which the United States developed, used and abandoned long ago. In other cases, the problems they face on return are problems we never had in the United States" (Mosher as quoted in Wharton, 1959, p. 25). McMeekan comments on the same point: "But what these new nations see is the agricultural research of today and not that of yesterday. They see thousands of scientists in the United States engaged in highly specialized studies geared to a future already within the grasp of such a sophisticated agricultural nation... Their work of today is no longer dominated by immediate usefulness. It lies in fields that are often only remotely connected with agricultural production, as it now exists" (McMeekan, 1965, p. 72).

Educational programs for foreign agriculturists in the United States face serious problems. It appears that in some cases inappropriate personnel have been selected for training, ones having little interest in or knowledge of production agriculture. In many

cases the nature of degree requirements set by graduate schools and academic departments--emphasizing increased specialization, the orientation of research to different types of agricultural problems and the use of inappropriate methods and techniques--severely limits the direct application of such advanced training to the task of solving the serious agricultural problems of LDC's. While these serious problems are recognized, the fact remains that most LDC's lack adequate institutions of higher learning--particularly in agriculture--that can supply the technical personnel needed for agricultural research (and extension) programs. Until this capability has been increased and strengthened, it will be necessary to carry out much of the advanced academic training of agricultural scientists in foreign universities of the industrially developed countries.

While the task of higher education must largely rest with the university--be it foreign or local--a different type of training and training institution is being looked to as a possible solution to some of the technical manpower development problems currently being faced by most LDC's. These institutions are the international agricultural research centers which have been quite successful, to date, in developing the Green Revolution technology that has accelerated wheat and rice production in many Third World countries.

The remainder of this study will be devoted to an examination of the training programs of the two older international institutes: The International Rice Research Institute (IRRI) located in the Philippines and the International Maize and Wheat Improvement Center (CIMMYT) located in Mexico. The focus of this research

will be on the types of people these institutes are training, the type of training provided and the types of jobs for which participants are being trained. The study will also determine how many returnees are working in the skill areas for which they were trained, how much of the training is being utilized on the job, how the training has influenced the work behavior of former trainees, etc.

The purpose of this study is not to compare the training efforts of one center against the other, but to make as explicit as possible the training strategy being followed by each Center and then to examine this strategy (1) conceptually, in terms of the research and extension jobs needed to be carried out in LDC's if agricultural and food production is to be increased and (2) empirically, in terms of what trainees are actually doing and how useful the training has been to these participants in helping carry out these particular jobs. In undertaking this study, the primary objective of the investigator was, first, to facilitate an exchange of ideas and methods between the two centers directly involved in the research and, second, to allow the newly established institutes to learn from the experience of the older institutions.

CHAPTER III

THE CIMMYT WHEAT PROGRAM

Introduction

The wheat training programs of CIMMYT were selected study in this research since they had sufficient size (number of trainees), program continuity, and length of operation to allow participant follow-up study. To fully understand the wheat train ing programs and the institution building strategy they imply, it necessary to first understand the structure and function of the CIMMYT Wheat Program in Mexico and the component parts of CIMMYT's cooperative programs with national programs.

The Objectives of the CIMMYT Wheat Program

The objective of the CIMMYT wheat program is threefol

1. To help governments develop wheat improvement programs and to supply germ plasm, technology and training of national scientists for those programs, in order to benefit the largest possible number of farmers, especially in developing countries.

2. To increase the efficiency of grain production, as measured by yield per unit area and by lowered cost of production, in order to help wheat grower achieve a greater net income, and to ensure an adequate food supply at economical prices for entire populations.

3. To improve the nutritional quality of wheat, especially protein quality. (CIMMYT Annual Report, 1970-71, p. 11)

The organization of the CIMMYT Wheat Program, in carrying out the objectives listed above, can be broken down into two types of activities: the research program in Mexico and the international cooperative programs. Many of these programs have been described in detail in CIMMYT reports and from special perspectives by other authors. Perhaps the most comprehensive overview of CIMMYT and its transition from a national agricultural improvement program to an international research center can be found in a book by E. C. Stakeman, R. Bradfield, and P. C. Mangelsdorf, entitled Campaigns Against Hunger. This section is not designed to be a review of this literature, or even a background statement about how CIMMYT developed. Rather the objective is to describe some of the key characteristics of the CIMMYT Wheat Program that are unique to this international center and this varietal improvement program. All of these factors play important roles conceptually or functionally in making up CIMMYT's international wheat improvement strategy, of which training is of instrumental importance.

The Wheat Research Program:

The CIMMYT Wheat Improvement program in Mexico is a research effort designed to increase the genetic yield potential of the wheat plant by combining within germ plasm and varieties resistance or tolerance to limiting factors--particularly diseases, but also insects--with other yield increasing characters that will allow the more efficient utilization and conversion of solar energy and nutrients (including water) to increase wheat production per unit

area.

It is important to understand that in addition to genetic improvement, production can also be greatly influenced by the growth environment in which a particular variety is grown. Research directed at these agronomic questions is considered by CIMMYT to be location specific; therefore, little direct research attention is given to these problems in Mexico. Instead nearly all attention is focused on the genetic component of wheat technology.

Breeding for Widely Adapted Genetic Material

It is in large part serendipity that the concept of widely adapted germ plasm came out of the CIMMYT Wheat Program. Here is a brief explanation as to how this happened. To breed, select, and release a new wheat variety requires 7 generations. In order to shorten this time (normally a minimum of 7 years), Dr. N.E. Borlaug, Director of CIMMYT's Wheat Program, established a high altitude summer nursery in the valley of Toluca to add an additional growing season per year to compliment the regular wheat breeding season (winter nursery) in Northwestern Mexico.

Environmentally the two nurseries are distinctly different, almost to the point of representing near opposites vis-a-vis spring wheat production. Some of these important environmental differences represent variations in photoperiod or day length, seasonal temperature patterns, amount of precipitation (wet rainfall vs dry-irrigated), level of solar intensity, disease incidence, changes in

soil types, etc. By selecting plants and lines through succeeding generations in alternating growth environments, the wheat team was in effect, selecting germ plasm for wide adaptability. Thus, while the summer nursery in Toluca did cut the varietal development process to 3 1/2 years, instead of seven as was true before; it also had the unforeseen result of producing widely adapted germ plasm and varieties. Now this concept is recognized and the advantages of this procedure are built into the research program. While the advantage of widely adapted genetic material is that it can be grown in many different countries of the world, this advantage can also be a disadvantage. If a variety is extensively grown over wide areas, there is increased vulnerability due to the problem of disease epidemics. This problem is recognized, and precautions at both the international and national level are taken to minimize the occurrence of this problem.

Selection of Germ Plasm Under Highly Hostile Environments

Another characteristic of the breeding methodology, which also contributed to the wide adaptability of CIMMYT's germ plasm, is the breeding and selection of segregating lines under harsh or severe environments vis-a-vis specific limiting factors. For example, a severe outbreak of stem rust may occur once every few years in northwestern Mexico. Therefore, under natural conditions a breeder will have less opportunity to identify and select disease resistant plants and lines in the early segregating

generations. Even with artificial innoculations the disease may develop too slowly to afford the breeder a good selection tool in the dry conditions of Sonora. But in the cool wet environment of the summer nursery near Toluca the growing conditions are ideal for disease epidemics; therefore, a plant must be resistant to stem rust to survive in this environment.

The problem is that highly hostile environments for certain diseases and insects are not available in every country or even in every continent. For stripe rust, CIMMYT must go to Colombia for sources of resistance and for sufficiently hostile conditions where germ plasm can be screened for resistance or susceptibility to this particular disease. For Hessian Fly, the most hostile environment for selection is North Africa with the source of resistance probably coming from winter wheats (CIMMYT, 1972, p. 3).

The point is that certain diseases and insects are economically important (i.e., will greatly reduce production) once every 2, 5, or more years--whenever a certain combination of factors is right for an epidemic to occur. A country needs protection for the year when a potential epidemic can occur; yet, there is no easy or effective way that national breeders can identify resistance or tolerance to these potentially limiting factors until an epidemic does occur. Therefore CIMMYT brings together sources (genes) of resistance to all of the economically important limiting factors (insects and diseases), builds these sources of resistance into a wide assortment of elite germ plasm by selecting lines in the most severe environments that can be artificially created or found in

nature for each specific limiting factor, and then makes this germ plasm available to the appropriate national programs that need specific types of resistance.

In building in specific types of disease resistance (as well as other characteristics) CIMMYT scientists sometimes have to go to exotic species of wheat to find genes of resistance. In the process of crossing between elite and exotic material, the breeder may gain the disease resistant gene he is looking for in the progeny, but lose the productive characteristics of the elite parent. Without getting bogged down in a technical discussion, let it suffice to say that the procedures of bringing in new sources (genes) of resistance can be a long, complex, and expensive procedure, requiring hundreds of crosses, with successive selections and recombinations--all of which must be done in a hostile environment, so that plants carrying the resistant gene can be identified.

While this process may seem a bit complicated to the layman, who has little understanding of genetics and plant breeding, these procedures are straightforward for the plant breeder. What makes his life complicated is the fact that Mother Nature is busy breeding (through natural evolution) new races of disease organisms that will attack the resistant varieties. Thus the average lifespan of a Mexican variety has been about 5 years, after which it must be replaced by a new variety that has a different combination of resistant genes or a new source of resistance altogether.

The Structure of the CIMMYT Wheat Research Program--
An Integrated Interdisciplinary Research Team

The CIMMYT Wheat Program represents what this writer considers to be a good example of interdisciplinary research. The program structure will be examined and at the same time used to provide a definition of interdisciplinary research as it is used in this study.

The organization of the CIMMYT Wheat Program is broken down on the basis of types of cereals included for improvement in the total program. Therefore there are teams for (1) bread wheats, (2) durum wheats, (3) triticale, and (4) barley (started in 1972). The unique aspect of this approach is that scientists, regardless of disciplinary backgrounds, work together on the same material in the same plots. To demonstrate how and why this structure is unique, the CIMMYT varietal improvement program will be contrasted with traditional breeding programs in the United States.

In the traditional structure, pathologists, entomologists, and cereal technologists generally work in programs separate from the plant breeder. For example, in the traditional form of organization, if a new source of resistance to a limiting factor is identified, that line is turned over to the plant breeder for inclusion into his program. After crossing the resistant line with other materials in his program, the breeder may then send selected lines from these crosses back to the pathologist or entomologist for screening to identify the resistant lines. The resistant lines, after being identified, are returned to the breeder for further selection and

eventual release. Thus it takes time for the pathologist or entomolo gist to identify sources of resistance, plus a minimum of another 7 generations for the breeder to incorporate this source of resistance into an advanced line that can be released, as a variety, to farmers. Of course this process is considerably more complex, since the breeder is trying to bring together in an individual variety many different agronomic characteristics, certain quality standards, several different types of disease and insect resistance, etc. The key point in understanding the traditional type of research organization for varietal improvement is that the specialists in each disciplir concerned with solving specific production problems through genetic improvement--work separately from the breeder. The breeder's job is to bring these factors together through an effective breeding program.

Basically what has been done in the CIMMYT Program is to condense all of these processes into one large-scale program so that each of the disciplinary specialists applies his specific skills to all of the genetic material in the total program. In addition, these specialists become actively involved in the crossing program--bringing various sources of resistance into a wide assortment of genetic material, some of which may eventually be released as varieties, or which will be further combined with other lines having different desired characteristics.

The CIMMYT type of interdisciplinary research in varietal improvement results in considerably different types of research behavior on the part of the other disciplinary specialists. Under

the traditional form of organization, the direct supporting role of the pathologist to the breeding program may have taken only a small portion of his total research time. The rest of his time may have been spent on related experimental (knowledge-generating) research within his discipline. Under the CIMMYT form of organization and with two breeding seasons per year the other specialists, as well as the breeder, have full-time jobs in the varietal improvement program--identifying new sources of resistance, combining sources of resistance through numerous crosses, making field notes, selecting from segregating material, and screening advanced lines.

While this form of organization is a highly efficient system for developing new germ plasm and improved varieties, it can also create a number of organizational problems. First is the fact that the professionally trained specialist in pathology, entomology, etc., does not want to become a "breeder"--which in effect is what he becomes under this system. The output (organizational goal) of this type of research is new genetic material and varieties--not research publications which is the criterion commonly used to evaluate professional competence in other research organizations. Under the traditional system the pathologist or entomologist can spend a small portion of his time directly supporting the breeding program, but most of his time must be spent on those activities which are specified as the basis for evaluation and reward.

A second problem is the fact that the team leader, who will evaluate the specialist's work performance, will probably be from a different discipline. Therefore, there is the potential problem

(perceived, if not real) that his activities may not be fully appreciated or properly evaluated. Professional scientists prefer to be evaluated by peers in their own discipline who are supposedly in the best position to evaluate research performance.

Another problem is that the individual scientist no longer has his own program which he can present to demonstrate his scientific competence for professional or organizational rewards. He is a part of a team effort and his efforts cannot be distinguished from that of the team. A professionally oriented scientist may find this type of structure particularly unattractive since personal professional goals are subservient to organizational goals which stress a different type of output.

A final problem which can be potentially damaging to a team approach is poor leadership. Obviously the team must be working on the correct problems, but just as important are the relationships among team members. The relationship question can be broken down into two main parts: decision making and the sharing of rewards/credit. In the case of decision making, each specialist has his own expertise which he contributes to the overall program. At the same time all functions and tasks must be integrated into the total program and certain tasks and activities must take priority over others. The team must operate in such a way that all team members participate in the decision-making process and that decisions are not made in an authoritarian or arbitrary manner. Finally, the rewards and credit that come to the team, must be shared by the team members and not be usurped by the team leader. If the attitude "we do all

the work and he gets all the credit" develops, then esprit de corps will be lost and the team will fail to function effectively.

The Genetic Assemblyline

It can be said that what Borlaug did for wheat breeding is analogous to what Henry Ford did for automobile production--that is to organize an assemblyline for the production of new genetic technology. While wheat plants don't physically move down a conveyor belt, they do move through a growing season and through a seven-generation varietal development process which affords the opportunity for the "standardization of procedures" and the "routinization of tasks"--the same elements that increased the efficiency and output of Ford's automobile plant. Before exploring how and why the CIMMYT program has moved in this direction, it is first necessary to establish some general parameters where these concepts are applicable in agricultural research.

As mentioned earlier, one of the problems of experimental research is that the scientist has to select or even develop special techniques or procedures to study special problems. As the research problem changes, new methods and/or techniques may be needed to continue the study of the problem as the body of knowledge expands. Therefore, knowledge-generating research will seldom be routinized to a series of uniform steps or procedures.

Research aimed directly at technology development objectives, however, affords considerably more opportunity to standardize

procedures and to routinize tasks. In these cases the content of the problem may change, but the general nature of the problem remains the same. Technology-development research in crop production is a continuing process of manipulating genetic and/or production factors (inputs) to achieve improved genetic and/or production technology (outputs) that will increase production, reduce costs, etc. For example, as the varietal improvement team combines different genetic characteristics to develop an improved variety of wheat, then the agronomic team must work to manipulate other factors of production in the process of developing an accompanying "package of practices" that will exploit this genetic potential to best advantage, given specified policy objectives, resource availability, factor costs, etc. within a particular country. The process of carrying out both functions allows opportunity for these procedures to be standardized and tasks routinized.

The CIMMYT Wheat Program is not the first research organization to apply these basic concepts to research. It is unique in the fact that it is the first crop improvement program to make such extensive use of these concepts. Why this highly efficient organizational development occurred is unclear; but, some of the factors which may help explain the evolution of this program are: (1) the interdisciplinary team approach to wheat breeding, and (2) the overall size of the program.

In the U.S., it is common for plant breeders to work separately, both from other disciplines and from other plant breeders. This division of labor results in each breeding

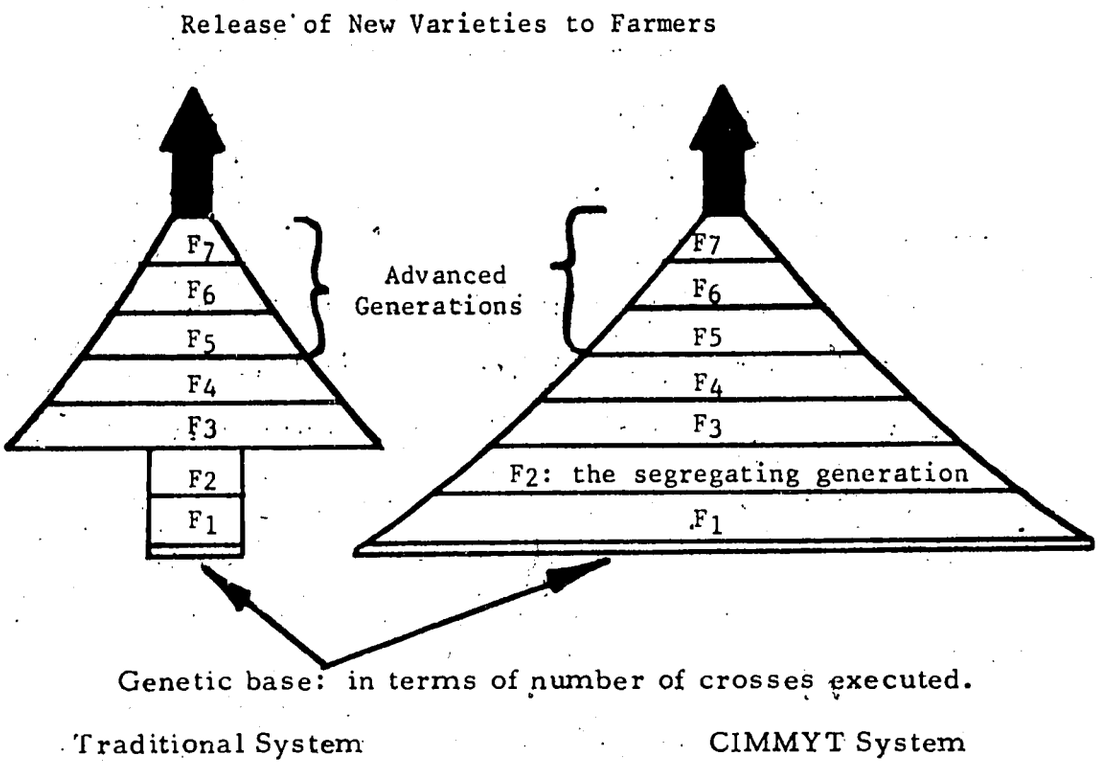
program following the same general breeding methodology or framework, but with each breeder using somewhat different operational techniques and procedures (such as methods of labeling, field notations, field layout, size of plots, organizing the field book, etc.) that suit his own needs or with which he feels comfortable. By introducing several scientists from several different disciplines into a single breeding program, certain uniform stand and rules of procedures must be followed if confusion and errors a to be minimized.

Another aspect of this same problem is information storage and retrival systems for interdisciplinary teams. In a one-man program, considerable information about the program can be, and frequently is, stored in the breeder's mind. With multiple scientist working as a team in one program, information storage must be completely on paper (i.e., in the field book) in a form that is easily accessible and understandable to all members of the team.

The CIMMYT Wheat Program deviates from traditional breeding methodology in the number of genetic combinations (crosses) made each year. Generally small-grain varietal improvement programs make anywhere from a few to several hundred crosses per season. In the F_2 generation (the segregating generation), however, proportionately larger numbers of plants are selected to be carried forward for further screening in the advanced generations. The CIMMYT program, however, starts the varietal improvement process by making several thousand crosses in each program (bread wheat, durum wheat, tritacle,

and barley) each year and then applies much more selection pressure during the early generations (F_1, F_2, and F_3), so that a manageable amount of material is carried forward into advance generations. Figuratively, the difference might look something like the following:

Figure III-1: Pictorial Representation of the Genetic Base of the CIMMYT and Traditional Breeding Systems



This difference in breeding methodology, while greatly increasing the probability of creating outstanding germ plasm, requires greatly increased efficiency on the part of the scientists in making this number of crosses and in handling the resulting early generation material. To help the team quickly and accurately identify

outstanding material, the CIMMYT program has borrowed, developed and adapted a number of "decision tools" which are an integral part of the genetic assemblyline.

The Development and Use of Decison Tools

Selection criteria and techniques in a varietal improvement program are critical if outstanding germ plasm is to be identified and improved varieties released. In most varietal improvement programs, selection criteria are based largely on what the breeder feels is most important. In addition, much selection is based on somewhat subjective, rather than objective data; or one might say, "beauty is in the eye of the beholder." In addition, after working several years with particular lines, some plant breeders can get "emotionally attached" to their "good" material and find it hard to differentiate and discard lines that are on the borderline between good and excellent.

Given the large number of crosses made in the CIMMYT program, the need to quickly identify the outstanding lines and the need to avoid being buried under thousands of excess lines, the CIMMYT team has incorporated into its genetic assemblyline a number of techniques which facilitate the decision-making process. Some of these decision tools are: early generation (micro) quality tests, rust readings under conditions of highly virilent rust epidemics, yield trials, etc. While most breeding programs may use similar techniques, the CIMMYT team systematically gets this information as early as possible to facilitate the selection process.

As soon as a line (in a specific generation) can be evaluated for a particular characteristic, it is, and if the objective measure of this characteristic doesn't meet (fall within) certain predetermined criteria (parameters) the line is discarded. In addition, in cases where decision making must be made on the basis of subjective evaluations, the appropriate specialist on the wheat team has the responsibility for these decisions, rather than relying on one man. This allows the CIMMYT team to start with a much larger number and wider assortment of genetic combinations and yet to quickly sift through these materials to identify the outstanding lines.

While it is possible for a smaller, narrower-based program to hit upon an outstanding combination which will result in an improved variety, the size and variability of the CIMMYT Wheat Program greatly increases the probability that outstanding combinations will be made and identified.

International Cooperative Programs

The international cooperative programs of CIMMYT reflect a clear, yet implicit, institution-building strategy. The purpose of this section is to make as explicit as possible what this strategy is, describing the component parts and how these parts are integrated into an international wheat improvement strategy.

The objective of the CIMMYT Wheat Program vis-a-vis this strategy is to "help governments develop wheat improvement programs and to supply germ plasm, technology and training of national scientists for those programs..." (Annual Report, 1970-71, p. 11).

In translating these objectives into programs, there are three major types of outreach activities: (1) training, (2) assignment of CIMMYT scientists in national programs, and (3) international nurseries. There are four smaller components of CIMMYT's outreach program: (1) consulting, (2) technical workshops, (3) orientation tours, and (4) technical information and reports. Before describing each of these functions, it will be helpful first to present an overview of what this writer calls the international wheat improvement strategy of CIMMYT.

International Wheat Improvement Strategy

It appears from examining the organizational structure of the CIMMYT Wheat Program, that it is trying to build strong, effective national wheat improvement programs that are closely linked to other national programs and CIMMYT for new genetic resources and technical information--through an international network of cooperating wheat improvement programs. The key concepts are independently functioning programs that are interdependent or linked together for the purpose of sharing germ plasm and/or technical information.

In building strong independent wheat improvement programs, CIMMYT will not work with any national programs unless specifically invited to do so and then only with full assurance of complete cooperation between the two programs. Once such assurances are given, CIMMYT plays an active role in developing specific types of research functions with the national program. While the level

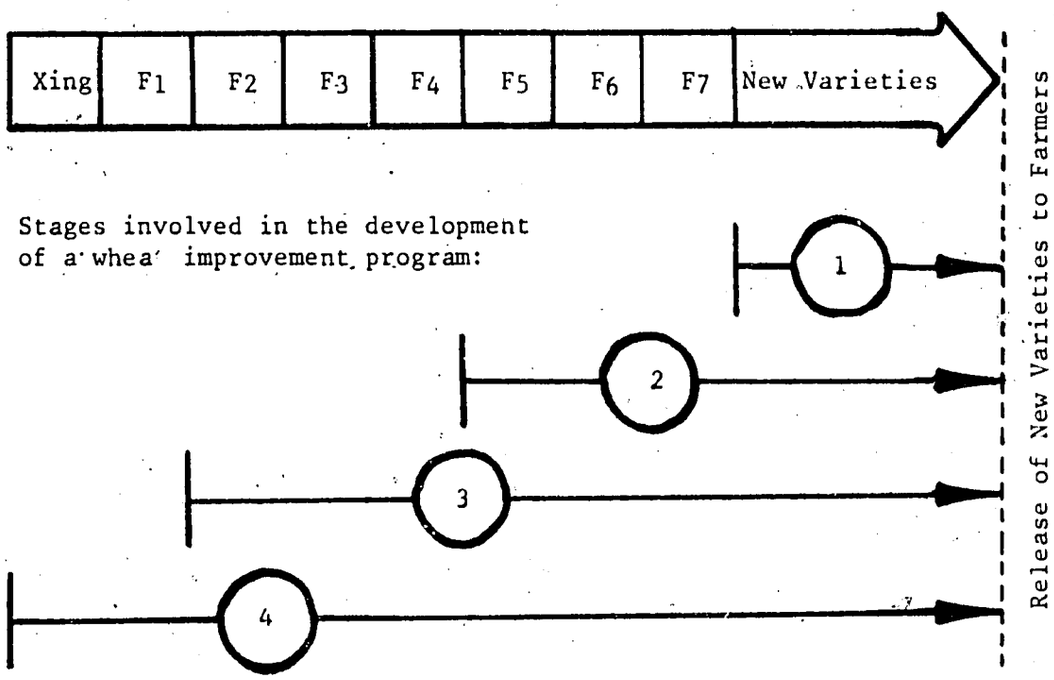
of involvement of CIMMYT in the national program depends on a number of factors--for example, whether a formal agreement has been made, the availability of financial and staff resources--the objective and the resulting procedures are generally similar. First, CIMMYT assesses the current status of the national wheat improvement program, and then through a variety of types and combinations of outreach activities, begins to build specific research functions within the national program that will result in improved wheat technology being made available to farmers as quickly as possible.

In cooperating with national programs, CIMMYT generally focuses on both genetic and production technology. However, this discussion will focus on training and institution-building functions as they relate to varietal improvement.

In considering CIMMYT's institution building strategy, it is possible to classify program development (for varietal improvement) into four general stages. These stages are (1) screening wheat technology (varieties) from external sources, (2) selecting from externally developed advanced lines, (3) selecting early generation lines from segregating material made available by CIMMYT and (4) a full-scale breeding program performing all phases of the varietal development process (but which may still work with and utilize externally developed germ plasm). The varietal improvement process is presented figuratively below, showing the four basic stages in the development of a fully functioning varietal improvement program.

Figure III-2: Stages of Program Development of a National Wheat Breeding Program.

Varietal Improvement Process



It is a relatively simple matter for CIMMYT officials to look at a national program, determine which functions are being carried on at the present time, make qualitative assessments of each of these functions, examine the technical training and research competence of the national staff, and from this information determine what type and how much assistance the program will need to eventually reach the stage of an independently functioning varietal improvement program.

While CIMMYT never explicitly suggests that the national program adopt CIMMYT's research methods and procedures, it is obvious that the standardization of procedures between programs is as important as within programs. Therefore, in national programs

that are poorly organized, staff members are sent as quickly as possible to Mexico to begin learning these procedures and methods. In addition, if the government wants to move quickly, CIMMYT staff members may be assigned to work in the national program to develop a fully functioning program as soon as possible. By adopting CIMMYT's methods and procedures, the national program is able to shift immediately to what is taken to be the most efficient breeding methodology for wheat improvement in the world--and this in turn allows for the easy movement of germ plasm and technical information between programs with little or no confusion or difficulty. Over a period of several years, as more and more national staff members are trained and the research capability increases, the national program takes on the full varietal improvement process with CIMMYT eventually serving as only a source of new germ plasm (that cannot be developed or tested locally because of inadequate disease-screening environments) and as a coordinating agency to foster and facilitate cooperation between national programs.

CIMMYT Staff Assignments in National Programs

Where a national government desires to quickly develop an effective and efficient wheat improvement program, they may enter into agreement with CIMMYT (and generally a third agency which provides financial support for the project) to assign working scientists from CIMMYT within the national program. The objective is for the foreign scientist to establish a fully operative varietal improvement program while technical staff from the

national program are being trained in Mexico. After the program is operating normally and after trained people are available, the foreign staff members can be slowly phased out.

Timing is largely dependent on the availability of technical personnel within the national program with adequate educational background as well as on research leadership. Practical training must be supplemented with educational (degree) programs. Because of the lack of personnel with sufficient university education, the institution-building process may take more than a decade before an independently operating program can be developed. Also it is necessary for research directors and wheat program leaders to fully understand the objectives and operations of a CIMMYT styled research program so that trained personnel will not be limited by organizational obstacles upon their return home. CIMMYT assigned staff members can usually resolve many of these institutional problems, but orientation tours to Mexico by national officials and scientists, as well as visits to the national program by senior CIMMYT staff members, can also help resolve organizational bottlenecks that may develop in the process of building an effective wheat improvement program.

The Training Strategy

Training is used by CIMMYT as an important tool in bringing about organizational change within national wheat improvement programs. In many cases national programs lack clear direction or aggressiveness in trying to solve the

problems of agricultural producers. As mentioned earlier, efficient research methodology and procedures can be one limiting factor to organizational effectiveness. Another problem area that is considered as very serious by CIMMYT is the normative structure of the national program concerning practical, problem-solving research; hard, back-breaking field work; working closely with farmers, cultivators, and peasants, etc. As will be seen later in the section on actual training objectives and methodology, CIMMYT considers attitudinal change among research workers and normative change within wheat improvement programs as a key factor in improving organizational effectiveness.

CIMMYT staff members think that unless one has a national wheat team that is both motivated and dedicated to solving farmer problems, their research behavior will not likely result in a continuing output of improved wheat technology for farmers to use in increasing production. One important objective that is implicit within CIMMYT's training strategy is to train a minimum "critical mass" of research workers within the program to bring about organizational change. The idea of reaching this critical mass of trained research workers is tied to two fundamental operational objectives. First is the need to change and maintain new "working rules" within the national program that reflect an aggressive, farmer-oriented, practical, problem-solving approach to wheat improvement. These new working rules usually mean different research objectives and functions as well as a different normative structure within the national program. Second, is the need to develop a working team

of research workers with sufficient competence and depth to implement an efficient wheat improvement program patterned after the CIMMYT model and at the same time adapted to suit local institutional and technical requirements.

The concept of a critical mass, as used here, cannot be defined quantitatively (for example by classifying the research staff). Instead the concept is tied to (1) having a sufficient number of staff members, at various levels of authority in the organization, to change and support the working rules of the national program along the lines of a CIMMYT style approach to wheat improvement and (2) having a sufficient number of technically competent research workers to implement such a program.

International Nurseries Program

As trained research workers return and begin to translate their training into efficient research programs, producing new wheat technology, CIMMYT can provide germ plasm at various stages of varietal development to accelerate the program development process. Referring back to the previous figure concerning the four stages of program development, there are corresponding nurseries[1] for each stage. These nurseries are: (1) varietal

[1] An international nursery consists of identical selections of experimental lines sent to a group of cooperating scientists. In the case of yield trials, the lines are grown under specified conditions in comparison with local varieties; the results of which are reported back to CIMMYT for analysis, publication and distribution back to cooperating programs. Other nurseries (2-4 above) are sent to introduce germ plasm into the cooperating program.

yield trials, (2) screening nurseries (advanced lines), (3) F2 segregating nurseries, and (4) CIMMYT's current Crossing Block. Returning trainees may take all, some, or none of these nursery programs with them, depending on the stage of program development within the national wheat improvement program. This usually depends on a qualitative assessment of the individual program including such factors as: how many research workers have been trained previously, how effective their efforts have been, which nurseries have been sent in other years, etc. If a program is just getting started and still has a weak technical staff, only the screening nurseries and yield trials may be sent, so that the program can begin to evaluate externally developed technology and possibly begin releasing improved wheat technology to farmers within a year or two. As additional staff members are trained, the crossing block and F2 nurseries may be sent, so that within two to four years a full-scale varietal improvement program can be established and functioning at all levels within a national program using the best germ plasm currently available throughout the world.

If this infusion of germ plasm were not available for these transformed wheat improvement programs, it would be a minimum of seven years before any new wheat varieties could (theoretically) be developed locally using the elite germ plasm. But in fact, it would be at least 12 to 15 years (at a minimum) before a continuous flow of new wheat technology would be available to farmers.

Finally it should be pointed out that international nurseries serve functions other than just supporting the returning trainees,

although this is an important one. CIMMYT also uses the various nurseries to screen germ plasm for general adaptability and to check disease reaction in different environments around the world. This information is used by CIMMYT and national programs in further improving the wheat technology being developed by these programs. In addition, and probably of greatest importance, is the continuing infusion of elite and genetically diverse germ plasm into individual national programs to represent the superior output of all cooperating programs around the world. By pooling genetic resources and technical information about these resources, the efforts of individual cooperative programs are quickly made available to national programs around the world.

Conclusion

The wheat research program in Mexico and the international wheat improvement strategy of CIMMYT represent highly integrated programs. The major objective of CIMMYT's research activities in Mexico is to develop and make available to national programs genetic material that they themselves are unable to produce because of lack of technical, financial, or environmental resources.

The major objective of CIMMYT's international wheat improvement strategy is to work through various types and combinations of international cooperative programs to build strong, aggressive, and independently functioning national wheat improvement programs which seek to solve local farmer production problems and thereby increase national food production and reduce food costs.

While nations are expected to develop competent wheat improvement teams to focus on local production problems, these teams are also encouraged and expected to become participating members of an international wheat team that shares technical information and germ plasm in order to solve serious production problems on a regional or international scale.

For example, diseases such as stem, stripe, and leaf rust are transmitted through air-borne spores. Therefore rust epidemics are a potential regional, not just a national, problem. By having each national team operate a disease nursery at each main experiment station, and include all presently grown varieties in the region or world, shifts in races of rust due to a mutation of the disease can be detected early so that resistant varieties can be identified and made available to farmers before a major epidemic occurs. By encouraging this type of regular and systematic international cooperation, the technical resources and breakthroughs of individual national teams are quickly made available to other national wheat teams around the world.

This so called international wheat team also appears to be emerging as a substitute professional peer group for members of national wheat improvement teams (rather than a professional association based on a discipline or field of study). Regional wheat workshops serve the same function as professional meetings within scientific disciplines and research contributions to this new "professional group" (because it is interdisciplinary and problem oriented) are more commonly technological (germ plasm, technical

information and techniques), rather than knowledge oriented (i.e., research publications--contributions to a body of knowledge). Thus the dominant value held by this professional group is directed toward solving production problems with rewards and recognition given to those team members who make significant contributions in this area. Knowledge generation is not necessarily discouraged by this professional group, but is viewed primarily as a byproduct of the research effort--or something to be developed and/or used for instrumental purposes and not as an end in itself. Thus research publications are of a relatively lower priority as research output than some new type of wheat technology.

With this overview of the CIMMYT Wheat Program's research and institution building strategy, it is now possible to examine the objectives of, and methods used in, CIMMYT's wheat training programs to build specific research functions within national wheat improvement programs.

CHAPTER IV

THE CIMMYT WHEAT TRAINING PROGRAMS

Introduction

There are four different training programs available for in-service trainees coming to CIMMYT. These programs are wheat breeding, wheat pathology, cereal technology, and wheat production. The first three programs are all directly concerned with genetic technology, while wheat production is concerned with the accompanying package of practices which aim at exploiting the full genetic potential of each new wheat variety that is released within a country.

The procedure to be followed in studying CIMMYT's Wheat Training Program, is to divide the training experience into the three stages of training, as discussed on page 61 of Chapter II. These stages are: (1) pretraining, (2) training and (3) post-training. The procedures and objectives associated with each stage of the training process will be discussed and survey data presented to further document and to evaluate these activities. The final section will deal with the use of training on the job after returning home and an analysis of those factors influencing the use of training and work performance. This analysis, combined with trainee recommendations, will be the basis of specific policy recommendations to CIMMYT as to how it might improve its over-all manpower development efforts

in building strong, independent wheat improvement programs at the national level.

Methodological Note

The data to be used in this analysis were derived from a mail survey questionnaire that was sent to nearly all former trainees who had participated in CIMMYT's Wheat Training Programs. Before proceeding into this analysis, it appears useful to digress briefly to give the reader a general overview as to the number and types of respondents. For a more detailed description of the research methodology employed in this study, including copies of the data collection instruments, please see the attached appendix entitled, "Summary of Research Methodology."

In determining which trainees should be included in the study, certain criteria were established. First, that the trainee be back home on the job at least six months prior to completing the questionnaire and second, that the trainee had successfully completed more than two months of active training in Mexico. Using these criteria and after carefully searching CIMMYT's training files, it was determined that 197 former participants met that criteria. Of this group, however, there were no available addresses on file for 14 trainees. (Note: during the early sixties before CIMMYT was officially organized, information kept on trainees was sometimes less than adequate.) Therefore, only 183 former trainees were actually sent questionnaires, and of this group 134 participants responded, representing a response rate of 73.2%.

However, four questionnaires from one country were lost for several months and were received too late to be included in the analysis. Therefore, the actual number of respondents included in this study is 130 trainees.

In the decade that CIMMYT's Wheat Program has been conducting in-service training programs for wheat research and extension workers, participants have come from 37 different countries. The following table presents the number of trainees and respondents from each of these countries.

As mentioned previously, there are now four different training programs operating within the CIMMYT Wheat Program. Although each of these programs will be described separately, throughout the analysis portion of this study, the four groups will be considered as one. This grouping is necessary since the wheat production, wheat pathology and cereal technology programs started only recently and to date have had only a relatively small number of graduates. Because of this, the number of respondents in each of these individual programs is too small to permit statistical analysis. The actual number of respondents from each training program who are included in this study, are shown in Table IV-2.

Pretraining

The pretraining period includes the application and selection process when national program and CIMMYT official work together in evaluating potential trainees to determine if both the applicant and the program can make effective use of this type of training.

TABLE IV-1

Number of CIMMYT Wheat Trainees and Respondents by Country

Country	Number of: Trainees	Respondents
Korea	2	2
Bangladesh	3	3
India	2*	1
Pakistan	25*	21
Afghanistan	12	12
Nepal	2*	1
Iran	6	5
Iraq	7	5
Saudi Arabia	1	1
Jordon	4	3
Syria	5	4
Lebanon	4*	2
Turkey	16	13
Cyprus	2*	1
Egypt	7	5
Libya	3	1
Arab Rep. Yemen	2	0
Peoples Rep. Yemen	1	0
Tunisia	15	11
Algeria	12	9**
Morocco	14	5
Ethiopia	4	3
Sudan	4	4
Kenya	2	1
Tanzani	3	2
Colombia	1	1
Peru	2	2
Ecuador	5*	0
Bolivia	1	1
Paraguay	1	1
Chile	1*	0
Argentina	7*	2
Brazil	14	7
Guatemala	2*	0
Portugal	1	1
Poland	2	2
Romania	2	1
Not Ascertained		1
Totals	197	134

* Some addresses not available (14 trainees in total)

** Four questionnaires received too late

TABLE IV-2

Number of CIMMYT Wheat Trainees by Program

Program	Number of Respondents	Percent of Total
Wheat Breeding & Improvement	105	80.7 %
Wheat Production	14	10.8%
Cereal Technology	7	5.4%
Wheat Pathology	4	3.1%
Totals	130	100.0%

If the national government enters into a formal cooperative program with CIMMYT to upgrade its national program, generally three to five trainees will be accepted for training programs each year to quickly build the necessary critical mass[1] of trained research workers in the national wheat improvement program.

In the case of the Near East, CIMMYT works directly through Dr. Abdul Hafiz, the Food and Agriculture Organization's (FAO) Wheat Consultant for the Near East Wheat and Barley Improvement Program. In this case the FAO Consultant selects about eight wheat and barley research workers every other year for the CIMMYT wheat breeding training program. These trainees primarily come from the smaller Middle Eastern countries that do not have formal cooperative ties to CIMMYT.

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[1]See page 95 of Chapter III for a more detailed discussion of the "critical mass" concept.

Selection Process

Generally both the training institution (CIMMYT) and the national program participate in the selection process. In most cases the government (work organization) nominates candidates for the training program and CIMMYT has the option to accept or reject a candidate based in part on a field interview conducted by a CIMMYT official or a designated representative. In practice, however, a common working procedure has been for CIMMYT to agree to accept a certain number of trainees from a national program and then to accept those candidates that are nominated. Because of this operating procedure, it is necessary for CIMMYT officials and/or representatives to work closely (either formally or informally) with national programs, so that a maximum number of quality candidates are nominated by the government. As one representative who helps interview and select CIMMYT trainees put it, --this may require the structuring of selection requirements to fit those individuals within the national program who will make best use of the training. This helps to insure that these individuals will be "independently" nominated. Problems such as these result when the criteria used by CIMMYT differ from those used by the national program, possibly because of different organizational objectives and/or constraints. Because of these potential differences, the selection criteria used by CIMMYT and those within the national program will be discussed separately.

CIMMYT's Selection Criteria

The current CIMMYT procedure is to conduct field interviews with all applicants before they are accepted for the training program. Generally these interviews are conducted at the applicant's place of work and by a CIMMYT staff member or a designated representative.

Abdul Hafiz has been involved in the selection of over 60 CIMMYT wheat Trainees. Some of the characteristics he looks for in the selection of trainees are: young people between the age of 25 and 32 years who are energetic and willing to work; persons who have 3 or 4 years of practical experience working with a governmental wheat and barley improvement program; and those who have a B.S. or M.S. degree. He points out, however, that in some countries people with these minimum educational qualifications are not available; therefore, one must select the best available so that country's wheat improvement program does not fall too far behind other country programs in the region (personal interview with Abdul Hafiz, Dec. 12, 1972, Cairo).

Ignacio Narvaez, CIMMYT's representative in Pakistan's Wheat Improvement Program for five years (1965-70) and responsible for the selection of most of Pakistan's twenty-five wheat trainees, had this to say about the criteria he used in the selection process:

> First find out if they are interested in the work; are they asking about many technical things about the program, or are they more concerned about promotions, salaries and those sorts of things. Second are they really working in the plots, or do they spend much of their time talking or sitting under

> a tree. Finally, do they have a sense of responsibility about their job--do they stay and complete the work when it should be done, or do they stop working when the clock says its quiting time (personal interview with Ignacio Narvaez, September 27, 1972, Chapingo, Mexico).

These comments by Hafiz and Narvaez taken together reflect many of the personal and work characteristics that CIMMYT interviewers look for in potential trainees.

Selection Criteria Used in National Programs

The selection criteria used by national programs in selecting candidates can differ widely between programs; therefore, it is impossible to suggest how this process might occur within a particular program. In some programs candidates may be nominated on the basis of seniority, while in other programs merit or performance may be the dominant factor. In a few programs it would appear that an occasional trainee may have been selected on the basis of subjective criteria such as political, personal, or family ties.

Due to the time and resource constraints of this study, it was impossible to carefully examine the selection criteria and procedures used within each national program. Even so, there was considerable interest and concern on the part of one Center to know more about the nominating process, so that they might better understand and improve the overall selection process. Therefore, each trainee was asked to assess the level of importance of particular factors that may have been used in his own selection. The objective was

to get some measure of the importance of each of these factors throughout all national programs represented in the study. These data follow:

TABLE IV-3

Assessed Level of Importance of Specific Factors Used in the Selection of CIMMYT Trainees

	Level of Importance: N=130			
Factors	Very Important	Somewhat Important	Not Important	Don't Know or N. A.
Needed the Training to Do My job More Effectively	84.0% (100)	14.3% (17)	1.7% (02)	(10)
Member of an Accelerated Wheat Improvement Program	64.4% (67)	26.9% (28)	8.7% (09)	(25)
Educational Qualifications	50.5% (56)	46.8% (52)	2.7% (03)	(18)
Seniority--next in line for training	40.8% (40)	37.8% (37)	21.4% (21)	(31)
Language Ability (English)	36.9% (41)	42.3% (47)	20.7% (23)	(18)
Good Relations with Local CIMMYT Representative	26.8% (19)	22.5% (16)	50.7% (36)	(58)
Good Relations with Higher Officials in His Organization	22.0% (20)	19.8% (18)	58.2% (53)	(38)

The preceding data follow the general patterns that were expected, with objective criteria being mentioned with a higher rate of frequency than subjective criteria. Given CIMMYT's focus of building or upgrading the existing wheat improvement programs,

it was anticipated that being a current member of an accelerated team (where such exists) would be scored high by former trainees. Educational qualifications also played an important part in the selection process, suggesting that other research or extension workers in the program may have been passed over because they lacked the educational prerequisites for the training program. Approximately 50% of those trainees responding indicated that good relations with a CIMMYT representative had played some part in their being selected; with slightly over 40% suggesting that good relations with organizational officials also was helpful in their being selected (note the large number of non-respondents to these two categories). Obviously a number of different selection criteria are considered and weighed together in the process of selecting a trainee. Later in the study, these different criteria will be analyzed to determine if any are directly associated with work performance, use of training, etc. once the trainee returns to his home country..

While other types of selection criteria such as hard-working, energetic, highly motivated, etc., may be identified through field interviews, these characteristics could not be measured and presented in a study of this type. It is possible, however, to present some other types of quantitative data which will help to give a descriptive profile of those trainees who are being selected for training at CIMMYT.

CIMMYT Wheat Trainee Profile

The mean age of wheat trainees when coming to Mexico was

30.6 years. With the exception of one in-service trainee from Poland and one short-term visitor from Uruaguay (not-included in this study) all trainees have been male.

Educational backgrounds of trainees vary greatly from country to country. Generally CIMMYT requires a minimum of a B.S. degree or equivalent for acceptance into any training program; but as Hafiz mentioned, because of the lack of technically educated personnel in some wheat programs, trainees with only secondary school diplomas have been accepted. The following table indicates the number and percent of trainees at each educational level:

TABLE IV-4

Educational Level of CIMMYT Trainees Prior to Training

Highest Educational Level Attained	N	%
Gen. Secondary School Diploma	3	2.3%
Agric. Secondary School Diploma	18	14.1%
2 years of post-secondary school training in Agriculture	6	4.7%
B.S. Degree	75	57.8%
M.S. Degree	26	20.3%
Ph.D. Degree	1	0.8%
Total	129	100.0%
Number not responding	1	

As mentioned in the second chapter, several authors (Wharton, Mellor, etc.) have indicated that technical personnel selected for academic training in the U.S. frequently have urban

backgrounds; therefore, these types of trainees are considered to be generally unfamiliar with the agricultural problems of their countries. Since this seemed to be an important problem area, trainees were asked several questions to ascertain what proportion had agricultural backgrounds. First they were asked to describe the place where they lived most of the time until they were 12 years of age to determine how many grew up in rural areas.

TABLE IV-5

Place Where CIMMYT Trainees Lived Until 12 Years of Age

Place Lived	N	%
Rural	78	61.4%
Urban	49	38.6%
Totals	127	100.0%
Number Not Responding	3	

Next they were asked to give their father's occupation or profession to determine how many trainees came from farm families.

Finally respondents were asked to indicate if their family's income, when they were growing up, was mainly from agricultural sources; and if so, to indicate the primary source of that income.

While an agricultural background was never mentioned by CIMMYT officials as being a criterion for selection, 45% of CIMMYT trainees came from farm families with over 60% of trainees growing up in rural areas. While the proportion of trainees with agricultural backgrounds may not be as high as some might prefer,

TABLE IV-6

Occupation or Profession of CIMMYT Trainees' Father

Occupation or Profession	N	%
Farmer or farm worker	54	45.0%
Agriculturalist (Research, Extension, etc.)	3	2.5%
University Education	0	--
Elementary or Secondary Education	7	5.8%
Profession (Medicine, Law, etc.)	5	4.2%
Government Civil Servant	16	13.3%
Industry or the trades	9	7.5%
Business	24	20.0%
Other (e.g., military)	2	1.7%
Totals	120	100.0%
Number not responding	10	

given the observations by Wharton, Mellor and others, the percentage of CIMMYT trainees with farm backgrounds was higher than expected. Since the farm and non-farm groups are both large, this factor will be assessed later in the study to determine if an agricultural background has any influence on other factors, such as: the use of training, job performance, contact with farmers, etc.

CIMMYT trainees were all employed before coming to Mexico, and 97% were associated with wheat improvement work. Trainees, on the average, had been working 6 years on the job, before being selected for training in Mexico. Table IV-8 indicates the type of

TABLE IV-7

Main Source of Family Income When CIMMYT Trainee Was Growing Up

Main Source of Family Income			N	%
Agricultural Sources:	N	%		
Family owned and rented land	10	7.8%		
Family owned and cultivated land	46	35.9%		
Family rented or share-cropped land	3	2.4%		
Family members worked as agricultural laborers	0	--		
Other sources of agricultural income	2	1.6%		
			61	47.7%
Non-Agricultural Sources			67	52.3%
Totals			128	100.0%
Number not responding			2	

TABLE IV-8

Type of Organization CIMMYT Trainee was Working for when Selected

Types of Organizations	N	%
Government Research Organization	112	86.1%
Government Extension Service	6	4.6%
Agricultural College or Univ.	3	2.3%
Farmer Coop (Fecotrigo in Brazil)	9	7.0%
Totals	130	100.0%

organization trainees were working for when they entered the training program.

Since training in wheat production (mainly for extension workers) only started in 1970, it is not surprising to see that most trainees worked for research organizations. Next respondents were asked to describe the main type of work that they were engaged in prior to coming to the training site.

TABLE IV-9

Main Type of Work CIMMYT Trainee was Engaged in Before Entering the Training Program

Main Type of Work	N	%
Mainly Administrative	6	5.0%
Mainly Field Research Work	102	83.5%
Mainly Laboratory/Greenhouse Research	6	5.0%
Mainly Field Extension Work	8	6.5%
Mainly Teaching	0	--
Totals	122	100.0%
Number indicating some combination of the above types of work	8	
Number not responding	0	

Again the data reflect the fact that CIMMYT is primarily concentrating its efforts among field research workers. Those trainees engaged in laboratory/greenhouse research represent the cereal technology trainees, while the extension workers help make up the bulk of the wheat production trainee group. None of

the trainees were devoting much time to teaching, prior to coming to Mexico.

To summarize, it appears from the data presented that CIMMYT's selection procedures are very much in line with its overall training strategy; that is, to select relatively young, but experienced research personnel from national wheat improvement programs for the respective training programs. The next section will deal with the training programs themselves, describing the objectives, content, methodology and timing of each program. This descriptive material will be followed by a general evaluation of the wheat training programs by the Trainees' themselves--from the perspective of their job situation after returning home.

Training

General Training Objectives

Given the discussion earlier in Chapter III on the institutional objectives to be accomplished, at least in part through training technical personnel (see pages 89-98), it is now possible to consider the specific objectives of the training vis-a-vis the individual research worker. These objectives can be categorized into two general areas: (1) affective objectives, dealing with attitudinal change and creating a new professional orientation; and (2) technical objectives, which deal with improving and developing specific types of cognitive and psychomotor abilities. Since the objectives within the affective domain are more or less common to all four training programs, they will be discussed first.

Affective Objectives: Changing Specific Attitudes[2]

This area, like the others, is a complex group of factors (many of which are interrelated) which greatly influence the individual research worker's behavior on the job. Because of this effect on work behavior, CIMMYT considers attitudinal change as one of the most important objectives of the training experience. Before discussing two specific examples of attitudinal problems that have been identified and focused on by CIMMYT, it is necessary to preface this discussion by pointing out an obvious fact. Each trainee comes to the training site with a unique set of attitudes. Some trainees find little difficulty in accepting the working rules or normative structure of CIMMYT's wheat research and training programs. Others have lived and worked in greatly differing cultural and organizational environments and have had considerable difficulty in understanding and/or accepting CIMMYT's approach. Some apparently never bridge this attitudinal gap.

One of the more serious attitudinal problems of many research workers deals with research activities involving hard physical field work. Many trainees come from cultural backgrounds where "educated" people do not work with their hands. CIMMYT staff members strongly believe that if a research worker is to know his genetic material and is to make a contribution to wheat improvement, he must get into the plots and physically handle the material. Therefore, trainees are expected to carry out all of the manual

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[2]For a detailed summary of the process of attitudinal change, see pages 55-57 in Chapter II.

activities associated with a specific research function within a wheat improvement program. These activities go beyond just a couple of hours of field practice, but involve the completion of these tasks within the CIMMYT research program.

Another attitudinal problem area is the potential conflict between the hierarchy of authority within an organization and the technical expertise and knowhow of specific staff members in the process of carrying out an effective research program. CIMMYT wants trainees to understand that its not who you are, or what your title is or how many degrees you have obtained that is important in carrying out an effective research program. Rather, it is what each research worker knows, can do and can contribute to the total research effort that determines the effectiveness of the wheat improvement program. To demonstrate this philosophy, CIMMYT stresses the value of the team approach by drawing on each team member's technical expertise in making the best possible use of skills and knowledge at each stage in the varietal improvement process. One example of how CIMMYT dramatizes this point is when trainees are taught and evaluated on emasculating techniques by their bus driver. This particular individual has less formal education than any of the trainees, and has a low level position in the CIMMYT program; but happens to be a talented field assistant who has worked with the program for nearly 25 years and who has probably completed more emasculations and pollinations than the entire senior staff put together. He contributes this knowhow to the trainees and to the research program.

H. C. Kelman's theoretical framework of the processes of attitudinal changes (see pages 55-56) is particularly relevant in understanding these specific affective objectives. For example, some trainees understand or learn to understand the importance of actually working in the plots themselves and in carrying out many of the manual tasks associated with operating a field research program. These trainees see CIMMYT senior scientists, including Dr. Borlaug, out in the plots, "pulling plants" and carrying out other manual tasks. They may decide that if such behavior is not below the dignity of such prestigious men, then it might be appropriate behavior for themselves. In this case, it can be said that "identification" has occurred, because the behavior is associated with an admired person such as Dr. Borlaug. Later, after functioning as a "working" scientist for a season or two, former trainees will come to understand why this type of working behavior has been so productive. At this stage, the former trainee will have "internalized" this particular value.

Developing positive attitudes toward such types of behavior is not always successful. Some trainees will carry out these types of activities because they are asked or told to do so, but may make it clear that this isn't something they would do back home. These trainees have attitudes of "compliance," which means that they will behave in the expected manner to gain potential rewards (such as good letters of recommendation, fellowships, etc.) and/or to avoid negative sanctions. Once they return home, however, this type of behavior will not be continued.

Finally there is the occasional trainee or two who develops a severe case of "chronic flojera" during these periods and require extended periods of bedrest. These individuals make up the non-compliance group; but, rather than refusing to do certain types of work as requested, they generally prefer to avoid confrontation through a variety of different types of subterfuge.

By observing work behavior, both at the training site and once back home on the job, CIMMYT officials can fairly accurately determine the specific attitudes that trainees have toward different types of research work. This information is of considerable importance in building strong research teams, so research workers exhibiting the "desirable" types of behavior are singled out for recognition and rewards.

There are other areas of attitudinal change that CIMMYT concentrates on; but, the preceding examples show how attitudes and work behavior are closely linked. If CIMMYT expects the trainee to return home and to conduct aggressive, field-oriented wheat improvement programs that will help farmers, then he must understand and accept the idea that certain types of behavior are necessary, even though they may differ from the value systems within which he is used to operating.

Affective Objectives: Creating a New Research Outlook

The CIMMYT Wheat Training Programs give considerable emphasis to developing within each trainee a new "research outlook" or research perspective. This new professional orientation

focuses on how the research function is integrated into the overall wheat improvement program; and how these research activities are related to increasing agricultural production and the whole agricultural development process.

The first aspect of this objective is to impress upon each trainee the fact that he plays a very necessary and important role in the process of developing new wheat technology for farmers. Without his help and contribution, the effectiveness of the entire wheat team will be substantially reduced. Each trainee is made to understand that his success and the team's success depend on the full cooperation and participation of each team member. In addition each trainee learns how his function affects the work of other team members, so that when requests are made of him, he will know what output is needed and why. A good example of this team perspective is the relationship between the cereal technologist and the breeder.

All early generation material must be screened for acceptable quality characteristics. The cereal technology trainee works in the CIMMYT breeding program for a month before beginning work in the quality laboratory. He learns how crosses are made, how the breeder is trying to combine many different characteristics into single lines. He learns that because different parents have different genetic characteristics for cereal quality, that some lines may have outstanding agronomic characteristics, but may still be unacceptable because poor grain quality characteristics were transmitted in the genetic combination. After understanding how the breeder operates, then the cereal technologist understands

how important his function is to the total wheat improvement program; and, when the breeder asks him to work overtime between harvesting and planting (a 2-3 week period at CIMMYT), he knows that poor quality lines must be identified and discarded before the next nursery can be planted.

Likewise, the wheat breeding trainees spend a week or more in the cereal technology laboratory, learning how to conduct all of the quality tests. Again the idea is to learn the processes, procedures and problems faced by the cereal technologist, so that there is a common basis of understanding and appreciation of each research workers technical function and contribution to the total team effort.

The other aspect of the affective objective concerning research outlook or perspective concerns the role of farmer oriented research in the overall process of agricultural development. In this case the training site itself is uniquely suited to give a positive demonstration effect as to the importance of technological change to increased agricultural production.

The first half of the training is carried on in the northwestern part of Mexico, which is the major wheat-producing region of the country. The entire area is irrigated and was the primary beneficiary of the new technology that created the Green Revolution. Trainees are exposed to the most intensive and modern wheat cultivation in the world. After visiting farmers and agri-businesses in the area, it soon becomes clear why this area is so productive and how research has served as the engine of growth in this area.

All of the training (and research) is conducted on the government research station; but, the Mexicans in charge are quick to point out that the farmers levy a tax on their yearly production to support the agricultural research program. The farmers also purchased the land for the experiment station, and built and equipped the new research facilities on the station. Trainees can look across the fence from the research station into the adjoining farmer's field to see a "dwarf" wheat variety that was released only a year or two before. And at harvest time they can see the wagons and trucks, full of wheat, sometimes backed up for a mile; waiting to unload at one of several storage elevators in town. They can look at Mexico's wheat production statistics which show an increase in production from 727 kilograms per hectare in 1949 to 3,065 kilograms per hectare in 1970 (Proceedings, 1971, p. 67). They are also there to see the field days when the farmers arrive by the hundreds to see what new technology (varieties or recommendations) will soon be released. CIMMYT personnel don't spend much time on this aspect of the training function--they only let the trainees observe and let the Mexican farmers do the talking. It proves to be a very contagious means of stimulating enthusiasm for production oriented research.

Technical Objectives of the Training Programs

The specific aspects of these objectives differ between programs, but in general can be broken down into two major types: (1) cognitive/psychomotor objectives and (2) cognitive: synthesis

and evaluation objectives. The first group of educational objectives deals with the specific techniques, skills and technical knowledge required to operate a specific type of research program. Once the trainee learns the "nuts and bolts" of operating a research program, he then gives increasing emphasis to the content or the materials passing through the research program. For example, the job of the breeding team is to create (synthesize) new genetic lines and varieties by combining and recombining diverse types of germ plasm. Once new lines are created, they must be evaluated to determine if they are superior to existing varieties. Thus this second type of training objective deals with using existing theoretical (plant breeding and genetics) and methodological (CIMMYT's breeding system, skills and techniques) tools to develop and release superior wheat technology to farmers. A more detailed discussion of the content of each program; how these educational objectives are operationalized; and the training methodologies employed within CIMMYT's training programs follows. Prior to this, however, it should be made clear that CIMMYT trainees do not conduct any type of original research projects, but spend their entire time learning how to carry out specific functions of a wheat improvement program.

Training In Wheat Breeding

The training program in wheat breeding prepares research workers to conduct a full-scale varietal improvement program from making new genetic combinations (crossing) thru each stage

of the varietal development process, including yield testing and the eventual release of a variety. To do this CIMMYT employs on-the-job training (see Chapter II, page 58) within the actual CIMMYT program, whereby trainees learn the necessary skills and techniques and then work as research assistants in the on-going program, helping CIMMYT scientists complete each series of tasks as they move through the growing season.

Cognitive/Psychomotor Objectives

The regular winter growing season for (spring) wheat in north-western Mexico runs from about November 15-30 to April 15-30, followed by the summer nursery in the high altitude valley of Central Mexico running from about May 15-30 until October 15-30. Wheat-breeding trainees arrive in Mexico during early February when the wheat is about six inches high (early boot stage) in the winter nursery. After a short orientation period, trainees begin learning and helping to carry out the first major research task following planting; that is, to inoculate the segregating nurseries with rust spores (to artificially create a disease epidemic in the nursery). After learning about the various types of inoculating techniques, each technique is demonstrated and trainees are then given the necessary equipment and materials, and then proceed to inoculate the appropriate CIMMYT nurseries.

And so it goes through the winter growing season. Trainees learning and being checked out on specific research methods and techniques making crosses, note taking, making disease readings,

selection techniques, etc.[3] and then helping carry out these specific research functions through each stage of the growing season. The following list of "training lessons" taken from that manual, summarizes most of the skill areas covered during the training program[4] (CIMMYT, 1972a, pp. 12-13):

I. Breeding Goals and Methods:
- Determining breeding goals
- Sources of materials for introduction
- Methods for wheat improvement
- Wheat classification and origin
- Breeding of triticales
- Wide Crosses
- Durum breeding goals
- Hybrid wheats

II. Making the Crosses:
- Emasculation
- Pollination by the twirl method
- Preparing crossing tags
- Methods of recording pedigrees
- Selection of parents for crosses

III. Nursery, Design and Management
- Organization and field plans
- Seeding and management of nurseries
- Management of international nurseries
- Varietal yield trials
- Equipment for planting

IV. Note Taking and Records
- Field books
- Notes to take - general
- Recording agronomic data
- Recording pathological data

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[3]These are the cognitive/psychomotor objectives of the training program.

[4]See CIMMYT's Wheat Breeding Training Manual for an approximate schedule and description of activities covered during the training program.

V. Selection and Harvest
- Genetic basis of selection
- Selection
- Harvesting breeding materials
- Harvesting yield trials
- Preparing bags and envelopes
- Seed grading and quality tests

VI. Field Experiments and Reports
- Field trial objectives and designs
- Statistical analysis of experimental data
- Reports and recommendations

VII. Plant Pathology Skills
- Rust collection and inoculation
- Rust inoculations by spray
- Concepts of disease resistance
- Concept of specific and generalized resistance
- Diagnostic techniques
- Seed treatment
- Recording pathological data
- The rusts of wheat
- Principles of plant pathology
- Controling diseases of wheat

VIII. General Chemistry and Post Harvest Tests
- Wheat quality tests
- Commercial grading of wheat

XI. Miscellaneous
- Production skills
- Introduction to crop physiology

X. Seed Production and Certification
- Variety descriptions
- Roguing
- Seed multiplication
- Field and storage inspection for certification
- Laboratory tests
- Seed certification records

After harvesting in northwestern Mexico, the entire CIMMYT Wheat Program moves to the experiment stations (El Batan and Toluca) near Mexico City where the summer nurseries are immediately planted. Then for approximately 6 weeks, while waiting for the nursery material to reach the boot stage, trainees

participate in a number of laboratory, greenhouse and classroom activities. These activities include helping to prepare the seed packets (more than 200,000) for the different international nurseries; spending time in the milling and baking, and cereal quality laboratories learning how to run and interpret all of the basic cereal technology tests. In addition trainees may spend time with the wheat pathologists in the greenhouse learning to screen more exotic germ plasm for different sources (genes) and types of resistance.

Soon the material in the summer nursery has reached boot stage and the trainees begin working in the nurseries again, participating in each step of the varietal improvement program. When the summer nursery is harvested in late October, breeding trainees return to their home countries (generally with suitcases partially filled with seed packets) in time to help plant the winter nurseries of their national programs.

By following this type of schedule, wheat-breeding trainees can spend about 9 months in Mexico, yet have on-the-job training experience in 2 research cycles of the CIMMYT program. Two cycles appear necessary since the CIMMYT research program is very complex organizationally and genetically. The first cycle focuses primarily on the cognitive/psychomotor objectives of the program whereby trainees learn the specific techniques and methods of the CIMMYT research program. The second cycle gives the trainee a chance to see how all of these various research components are integrated into the over-all program (the synthesis and

evaluation objectives of the cognitive domain) and a chance for trainees to become familiar with the genetic material in the program. This second major group of training objectives will be considered next.

The Cognitive Objectives of Synthesis and Evaluation

Becoming familiar with the material in the CIMMYT program is no small or simple task. There are thousands of lines in the CIMMYT program and trainees must become familiar (i.e., be able to recognize, identify major characteristics, etc.) with at least the major varieties and lines used in the crossing program. For example an experienced plant breeder in the CIMMYT program can walk up to an advanced generation plot--and there are thousands of such plots--and from only visual inspection be able to give the approximate pedigree of the line, give several reasons why the cross was made and evaluate the line for these characteristics.

Synthesis: The job of research workers in varietal improvement is to plan and execute new genetic combinations to overcome specific limiting factors that occur in the wheat growing regions of their respective countries. Unless they know which varieties and lines have the genetic characteristics they are trying to combine, which lines combine more effectively, etc., they will be very inefficient and ineffective in developing new, high yielding varieties for their farmers.

Evaluation: It should be noted that one important aspect of the training methodology, in addition to just working on the job, is to increase the observational skills of trainees by forced decision

making. As trainees go through the plots (for example while taking field notes) they are continuously asked to make decisions (that directly affect the CIMMYT research program) and to give reasons in defense of their position. Particularly because of the peer group and staff pressure that is applied, trainees are highly motivated to open their eyes and develop their observational skills.

During the second research cycle (summer nursery in Toluca) trainees begin to make genetic combinations and selections for their home research programs. Allowing the trainee time to work on his own studying the CIMMYT materials vis-a-vis the growth environment in his home country (climate, soils, diseases, cultural preferences, etc.), lets him begin to make decisions that will affect his home country research program, before leaving Mexico. If he has questions about the genetic material, he can ask senior scientists in the CIMMYT program who are knowledgeable about the available genetic material and growth conditions in his country.

Training In Cereal Technology

The training program in cereal technology is designed to prepare a trainee to conduct all of the wheat quality tests necessary to screen and evaluate genetic material moving through a varietal development program. A cereal technologist trained in this program is prepared to serve as an integral member of a national wheat improvement team.

The training program generally runs for about four months from the middle of March through the latter part of July. The first

month is largely spent in the field research program working with the wheat breeders. Dr. A. Amaya, who is in charge of CIMMYT's cereal technology laboratory and these particular trainees, insists that this field experience in the breeding program is essential if they are to understand how cereal technology fits into the overall wheat improvement program (personal interview, Sept. 28, 1972, El Baton, Mexico).

After working in the breeding program, these trainees assist the laboratory staff to establish a temporary cereal technology laboratory at the CIANO Research Station in northwestern Mexico where CIMMYT's winter nurseries are located. The trainees help assemble the lab equipment (which has been shipped up from CIMMYT headquarters) and then learn how to calibrate each piece of equipment. Finally trainees learn how to run each quality test and are checked out on their technique by running a series of samples with known quality test values.

By this time harvesting work is beginning in the test plots, and early generation lines are being sent to the laboratory to be screened for cereal quality. Hundreds of early generation lines must be evaluated during a 3-4 week period between harvesting (at the winter nursery) and planting (at the summer nursery in Central Mexico). If a line passes these screening tests, it is shipped to the summer nursery and planted immediately. If the line doesn't meet certain predetermined quality standards, regardless of other desired characteristics, it is discarded from the program at this point. Trainees work directly in the laboratory during this period

helping the regular CIMMYT staff screen these materials. Trainees are rotated, so they receive several full days running each type of test.

When all of the early generation lines have been screened (by the end of May), the laboratory is dismantled and the equipment shipped back to CIMMYT headquarters near Mexico City. The trainees also return to CIMMYT headquarters and begin learning the other cereal quality, milling and baking, and protein quality tests that require more time, larger grain samples and/or more elaborate equipment. Again the training procedure is the same, with trainees being taught and checked out on a particular quality test and then working directly in the lab running tests on CIMMYT material. Dra. E. Villegas, who is in charge of CIMMYT's Protein Quality Laboratory, summarizes the "learning by doing" approach used in this training program: "Ask them to work as a staff member on the job--make them feel like they are part of the group. As soon as they learn, they work right in the program" (Personal interview, Sept. 28, 1972, El Batan, Mexico).

Training In Wheat Pathology

The training program in wheat pathology is nearly the same as the training program in wheat breeding. The only difference is an increased emphasis, at particular points in the growing season, on the important disease problems of wheat and the related skills and knowledge necessary to resolve these limiting factors. Trainees with specialized training in wheat pathology are viewed as integral

members of a national wheat improvement team. These team members concentrate on building disease resistance into varieties and germ plasm that are developed locally.

Diseases have always been the major limiting factor to increased wheat production. Particularly when wheat is grown under intensive cultivation, disease problems (such as the rusts) accelerate rapidly. Therefore genetic resistance to economically important diseases was and has continued to be a primary objective of the CIMMYT research program. However, as the Green Revolution varieties spread across much of the spring wheat belt of the wor the potential for disease epidemic has increased.

The job of each national wheat program and of CIMMYT is to continually widen and diversify the genetic base (sources and types) of disease resistance. Therefore, if a widely grown variety suddenl becomes susceptible, other varieties (with different types of resistance) must be available to take its place.

The CIMMYT wheat team has long recognized this problem and has worked hard to bring exotic sources and types of disease resistance into the research program in Mexico. According to Dr. Rajaram, one of CIMMYT's pathologists, this requires thousands of genetic combinations and recombinations each year to facilitate a continuous mixing of the gene pool (Personal interview, Sept. 22, 1972, El Batan, Mexico).

To give some idea as to the magnitude of the task, the CIMMYT Wheat Program (including all programs: bread and durum wheats, triticale and, starting last year, barley) makes

around 12,000 crosses each year. By the end of 1972, the bread wheat program (which is the oldest and largest of CIMMYT's wheat program) had completed more than 53,000 crosses.

Trainees who specialize in wheat pathology work closely with CIMMYT pathologists learning to identify new and different sources of resistance and then work directly with the breeders to bring new sources and different combinations of disease resistance into the program. They also learn how to artificially create disease epidemics in the breeding nurseries and then work with the wheat pathologists in taking disease notes and in selecting disease resistant material.

It should be noted that all CIMMYT wheat trainees receive training in wheat pathology and must be able to take rust notes, etc. The difference is that wheat pathology trainees receive more intensive work experience in this area.

Training In Wheat Production

The training program in wheat production was started in 1970 and is designed to prepare production agronomists who can develop and extend to farmers a "package of practices" to exploit the genetic potential of the high yielding varieties. Their job, as members of a national wheat improvement team, is to conduct agronomic field trials and carry out high yielding production plots to bring the improved wheat technology to the farmer. In addition, wheat production trainees are prepared to organize and conduct production training courses in their home country programs.

The wheat production trainees follow one complete cycle of a regular wheat growing season. Trainees arrive in Mexico the beginning of November and proceed immediately to CIANO in Northwestern Mexico. Here they plan and carry out two different experiments (agronomic trials). Some trials are on the research station while others are "on-farm" trials, where trainees rely on using the farmer's equipment.

The training methodology used in this program differs from the other CIMMYT wheat training programs in that CIMMYT does not have a full-scale, on-going agronomic research program in Mexico. Agronomic practices (such as fertilizer and planting recommendations) are considered to be largely "location specific," that is, research problems that national programs must solve for each different wheat growing environment in their respective countries. Therefore the training methodology used is a form of classroom instruction and field practice, revolving around the agronomic trials being conducted by the trainees. (It should be noted that the Mexican Agricultural Research Institute /INIA/ does conduct agronomic trials on wheat at CIANO and while CIMMYT trainees do not work extensively in these programs, they do visit and observe how these trials are carried out.)

After the research trials are in the ground (by the middle of December), the trainees return to CIMMYT headquarters near Mexico City where they are located until the wheat breeding and patnology trainees arrive in early February. During this 6-week period trainees study communications, agricultural development,

and statistical techniques for analyzing field data. After the other wheat trainees arrive, they return to CIANO to continue work (e.g., note taking, etc.) on their agronomic trials and to participate in the CIMMYT research program. Again the idea is to give the production agronomist a working knowledge of the procedures used in the varietal improvement program. Wheat production trainees, as well as the other wheat trainees, visit farmers' fields, attend field days and generally gain an overview of the wheat revolution that has occurred in northwestern Mexico.

After harvesting their field trials, wheat production trainees return to CIMMYT headquarters to analyze their data and to prepare production recommendations from this data. After writing and presenting their research reports (to other trainees), these trainees return to their home countries around the middle of June.

Conclusion

The overall objective of CIMMYT's wheat training programs is to change research and extension worker behavior by: introducing trainees to new attitudes and research perspectives (affective objectives); by teaching them new research skills, techniques, methods and knowledge (cognitive/psychomotor objectives); and by helping them learn to create, develop and refine new forms of genetic and production technology (synthesis and evaluation objectives of the cognitive domain) for farmers. While behavioral change is the objective, this goal may not always be adequately achieved in all cases.

People, like plants, segregate for different characteristics. Some of these characteristics are desirable, while others are not. Some characteristics, like color of hair or eyes, are easily identifiable. Other factors such as an individual's attitudes, his research outlook and his technical know-how, can be identified, but special techniques may be required to measure or determine how these factors differentiate among trainees. The way CIMMYT observes how trainees differentiate for different factors is much the same as the techniques used in differentiating among wheat plants--by putting the trainee in different types of environments to see how he reacts.

There is a common expression used in the CIMMYT wheat training programs. It goes something like this: "The plants are talking to you, but you have to use your eyes to hear what they are saying." In other words, wheat plants being grown under a variety of different conditions (favorable and hostile environments) respond differently to those conditions. A good observer is able to detect how plants react to each of these different environmental conditions and based on all of this data, select those genetic lines with the greatest potential.

It appears that CIMMYT is using a similar selection technique with its trainees. For example, CIMMYT has been criticized by some visitors to the training programs in Mexico for "using" trainees for such routine tasks as inoculating segregating populations with rust spores. This is a job that CIMMYT needs to have done and requires about 10 days to 2 weeks of hard, back-breaking work, wading through muddy plots (many times in

the rain), injecting two tillers of each plant with a syringe full of disease innoculum.

It is obvious that after the first morning of this activity, there is no additional technical training value to be accomplished. However, what the CIMMYT staff learns about the "trainee population" during these two weeks is very important. Some trainees can disguise their displeasure for this type of work for a morning or two, but after a week or 10 days, trainees are clearly segregating in their "reaction to hard field work." Some trainees may do the work while CIMMYT staff members are nearby, but then relax under a tree when they leave (representing an attitude of "compliance," given this type of behavior). Still others may call in sick for a few days to avoid the work (non-compliance); while others are out in the plots getting the work done. CIMMYT particularly wants to identify this last group of trainees who either "identify with," or have "internalized" positive attitudes toward this type of research work. CIMMYT believes it is this last group that will begin to make up the hard core of working scientists within the national wheat improvement program.

The training program in Mexico is viewed by the CIMMYT wheat team as only the first step in a long-term process of building effective wheat research workers and national wheat improvement teams. Because of this long-run perspective, the training program becomes both a manpower development tool and an "early generation" selection tool. Trainees are observed in Mexico and again back home on the job. Those who excel in attitude, outlook, intellectual ability and technical know-how--in both working

environments--are identified as prime candidates for academic fellowships. By giving these individuals additional educational opportunities, it is hoped that they will become the research leaders in years to come. Also, by using the training program as a selection tool, the probability of awarding a Ph. D. fellowship to a research worker with less potential or to one having an "inappropriate research orientation" will be minimized. Given the comparative costs of a CIMMYT training fellowship (approximately $5,000./trainee) and the cost of a Ph. D. fellowship (estimated by one foundation official to be approaching $50,000./student), fellowship granting institutions might well consider looking at in-service training programs of this type as effective intermediate screening devices for their fellowship programs. Operating with this type of behavioral information, such agencies could be considerably more confident that only research workers who had proven themselves on the job would be receiving the relatively high-cost academic fellowships for study in foreign universities.

The preceding section presented an overview of the objectives, methodologies and technical content of each CIMMYT wheat training program. Next the effectiveness and usefulness of this training approach will be evaluated by the trainees themselves from the perspective of their work situation. Finally the training programs will be assessed as an intervening variable on the research behavior and performance of former CIMMYT wheat trainees. The real test of a training program is whether or not it produces results on the job, after the trainee returns home to the national wheat improvement program.

Trainee Feedback on the Training Programs

CIMMYT is working with trainees representing diverse backgrounds (see the section on trainee profiles) and different organizational situations. In spite of these many differences, CIMMYT attempts to provide the best possible training for each participant. This next section will give an assessment as to how each trainee viewed various aspects of the training program.

Adequacy of Pre-arrival information

Trainees were asked to assess the adequacy of information about the training program before coming to the training site. Of the 127 trainees who responded to this question, 33 (26%) indicated that the information was very adequate; 74 (58.8%) said it was somewhat adequate; 12 (9.7%) said it was somewhat inadequate; and 8 (6.5%) respondents said it was very inadequate. Next, trainees were asked to indicate which of several types of information they had received prior to their departure from their home country.

From this information a scale was developed to quantitatively measure the total amount of information received by each trainee and to differentiate among trainees as to the amount of information received. The mean of this scale, which runs from 0 to 5 types of information received, was 2.6 types. (This pre-arrival information scale will be used later in the study to determine if amount of information received by the trainee had any effect of the use of training after the participant returned home.) It was expected that as the training program expanded and became

TABLE IV-10

Types of Information Received by CIMMYT Trainees Before Coming to Mexico

Types of Information	Trainees receiving the information N	%
Specific Objectives of the technical training	73	56.6%
Outline of the proposed plan for the technical training	64	49.6%
CIMMYT administrative policies & regulations for trainees	49	38.0%
Relationship between the training objectives and the national wheat improvement program	77	59.7%
Information about Mexico	70	54.3%
Trainees not receiving any information	9	6.9%

better organized that trainees would receive more complete pre-arrival information. An analysis of the data, however, showed that there was little difference between years in terms of the amount of information that was received by trainees.

Finally trainees were asked to indicate the best source of information about the training program before their departure. Only the four sources of information mentioned most frequently are discussed here. It was not unexpected that former trainees were ranked as the best source of information, since CIMMYT attempts to build a critical mass of trainees within each national wheat improvement program. Each year over a several year period individual or small numbers of research personnel are

selected for training at CIMMYT. These early returnees become the best sources of information for trainees selected in later years.

The next source of information mentioned most frequently was the trainee's supervisor, which would also be consistent with the same explanation. CIMMYT officials or representatives were the third most frequently mentioned source of information, followed by other officials in the trainee's organization.

Trainees' Reaction to the Actual Training Program

First, trainees were asked to indicate how they found the level of the training program, considering their previous background and experience. Because of the diverse educational background of CIMMYT trainees, there was some concern at CIMMYT that the level of training was low for the trainees with more advanced training.

TABLE IV-11

CIMMYT Trainees' Assessment of the Level of Training by the Level of Education when Entering the Training Program

	Level of Training Was:			
Previous Educational Level	Too Elementary	About Right	Too Difficult	Total
Less than B.S. Degree	1	25	0	26
B.S. Degree	24	48	2	74
M.S. or Ph.D. Degree	6	20	1	27
Total	31	93	3	127
No. not responding: 3	$X^2 = 7.52$ with 4 df ($P = .11$, n.s.)[5]			

[5]The statistical notation listed above refers to a Chi-square

As anticipated some respondents (24%) felt the training was a little too elementary for them. It is interesting to note, however, that the bulk of these responses came from the middle educational group, rather than from trainees with M.S. and Ph.D. degrees. Some respondents reinforced this general observation, that the training was too elementary for them, by suggesting that trainees with higher levels of education be split into a second group and given a higher level of training with more opportunity to work directly with senior scientists.

Next, trainees were asked if the balance between theoretical instruction and practical training was about right. Nearly 55% of the respondents felt the training was too dominated by practical training; with 42.3% indicating a proper balance had been maintained. Only 4 respondents (3.1%) thought the training was too theoretical. While a majority of the trainees thought the training could have included more theoretical instruction, when asked which aspect of the training program they felt most satisfied with, practical field training was the answer most frequently given.

Since the research investigator had worked two years with this training program, he felt that some trainees tended to equate

(Footnote 5 continued) test of significance and indicates whether or not the independent variable (previous educational level) has any effect or influence on the dependent variable (skill competence achieved). Since the Chi-square test of significance will be used throughout this thesis, all relevant notations will be defined here: X^2 = Chi-square; df = degrees of freedom; P = probability of; n.s. = not significant; * = "significant" or significant at the .05 level; ** = "highly significant" or significant at the .01 level.

practical work, with less sophisticated research. Therefore there were occasional requests for more classroom and theoretical instruction; yet, this writer believed that many of these same trainees had failed to adequately grasp skills and complexities of running a CIMMYT styled wheat improvement program. While the staff never had adequate measures of achievement in the training program, it frequently appeared that trainees with more education and training realized earlier and more clearly the opportunity they had to work in and learn from a large, well-organized wheat improvement program. In making this realization, trainees appeared to have more self-motivation and worked hard to master the CIMMYT research methods and techniques.

To determine if these insights would be substantiated by the data, trainees were asked to rate the level of skill competence they achieved in learning wheat research and production skills. These data were tabulated by previous educational level, to determine if trainees with higher levels of education would achieve a higher level of skill proficiency. These data follow:

TABLE IV-12

Skill Competence Achieved by Previous Education Level for CIMMYT Trainees

Prev. Education Level	Became Familiar with the Skills	Learned the Skills	Mastered the Skills	Total
Less than B.S. Degree	9	13	4	26
B.S. Degree	11	46	18	75
M.S. Degree or higher	2	9	16	27
Total	22	68	38	128

N.A. = 2 $X^2 = 16.19$ with 4 df (P = .0028**)

Trainees with higher levels of academic training prior to the training experience did achieve higher levels of (self-assessed) skill competence, so this hypothesis was accepted. This finding takes on increased importance later in the study, when skill competence is related to use of training after the trainee returns home.

Next, trainees were asked to rate the adequacy of supervision and direction given by the senior staff. Since some CIMMYT staff members wondered if the training program was getting too big in recent years and that trainees were not getting adequate individualized attention, these data were tabulated by several year groupings (when the training was received). The objective was to determine if the smaller training groups in earlier years received better senior staff support than the larger training groups in the last four years. These data follow:

TABLE IV-13

Adequacy of Senior Staff Supervision and Direction by Year Groupings when the Training was Completed for CIMMYT Trainees

Years Training Received	Senior Staff Supervision & Direction was: Less than adequate	Somewhat adequate	Very adequate	Total
1961-65	0	8	15	23
1966-68	2	4	15	21
1969-70	4	16	21	41
1971-72	1	24	17	42
Total	7	52	68	127

N.A. = 3 $X^2 = 8.34$ with 6 df. (P = .2144 N.S.)

The adequacy of staff supervision has tended to skip somewhat as the size of training groups has increased; but, the relationship between these two variables is not statistically significant. While this trend was expected, it must be pointed out that there continue to be only a few individuals terming the senior staff support as less than adequate. Therefore, it appears that the trade-off between senior staff support and increased numbers of trainees (at least at current levels) is not resulting in a serious decline in the adequacy of staff supervision and direction given individual trainees.

Trainees were asked to rate the appropriateness of the technical skills that they received in Mexico, in regards to the job to which they expected to return. Respondents were generally very satisfied in that 90 (74.4%) felt the skills were very appropriate; with another 29 respondents (24.0%) indicating that the skills were somewhat appropriate. Only 2 respondents (1.6%) indicated that the technical skills and techniques were inappropriate.

It was mentioned earlier that practical field training was listed as one aspect of the training that respondents felt most satisfied with. In addition, trainees frequently mentioned that they were very satisfied with the research skills and methods learned and also with the good trainee/senior staff relations they developed during the course of the training program.

In regard to the aspects of the training that respondents felt least satisfied with, only one factor was frequently mentioned. Many trainees indicated that they wanted increased training and experience in specific skill areas. Generally these skill areas

were either wheat pathology or cereal technology. It appears that these respondents felt that the exposure received in these areas was inadequate. While it is unclear why these trainees wanted additional experience in these skill areas, this response probably reflects a concern for certain research functions that are not being adequately handled by their specific national program at this time. Perhaps these trainees feel that with additional training (and some equipment) they could begin to carry out some of these needed research tasks during their slack season. For trainees feeling strongly about obtaining these skills, it would seem advisable for CIMMYT to give them another week or two of experience in these areas rather than frustrating these positive, well-intentioned motivations.

Trainees' Overall Evaluation of the Training Program

In this section trainees were asked to evaluate the CIMMYT training programs from several different perspectives. These responses serve to summarize how trainees presently assess their previous training experience in Mexico.

First, trainees were asked to assess the technical training considering their previous training and experience. Seventy-five respondents (57.7%) indicated the technical training was very appropriate, with another 51 (39.2%) assessing it as somewhat appropriate. One respondent was undecided, with only two former trainees (1.5%) indicating that the technical training was somewhat inappropriate for their previous training and experience.

Next, respondents were asked to assess the technical training considering their home country conditions. These data follow:

TABLE IV-14

Appropriateness of Technical Training at CIMMYT, Considering Home Country Conditions

	N	%
Very Appropriate	70	54.7%
Somewhat Appropriate	47	36.7%
Undecided	3	2.3%
Somewhat Inappropriate	8	6.3%
Very Inappropriate	0	--
Total	128	100.0%
Number not responding	2	

Trainees were then asked to indicate how helpful the technical training at CIMMYT had been in furthering their own personal career plans. Seventy-one respondents considered the CIMMYT training as being "very helpful" to them, with another 40 rating the training experience as being somewhat helpful. Sixteen respondents felt it had made little or no difference in furthering their career goals, while 3 trainees thought the training had been detrimental to their career plans.

Trainees were also asked to assess the administrative support (for example: living accommodations, allowances, transportation and other services) they received during all phases of their training program. Again the response was

generally favorable with 78 respondents indicating they were very satisfied and another 34 indicating that they were somewhat satisfied. Eleven trainees took a neutral position, with 7 respondents indicating some dissatisfaction with the administrative support they received.

Next, trainees were asked to give an overall assessment of their total training experience in Mexico. These data follow:

TABLE IV-15

Trainee Satisfaction with the Overall Technical Training Program

Level of Satisfaction	N	%
Very satisfied	85	65.4%
Somewhat satisfied	42	32.3%
Neutral	1	0.8%
Somewhat Dissatisfied	2	1.5%
Very Dissatisfied	0	---
Total	130	100.0%

Finally, trainees were asked to assess the extent to which the training experience at CIMMYT had made a difference in their ability to help solve the agricultural problems of their country.

Then those trainees who felt the training had made some or an important difference in their ability were asked to explain why they felt this way. The reason most frequently mentioned was that "they felt better able to run a full scale research program." The next reason most frequently mentioned was the "increase in their technical ability" and this was followed by "increased confidence to

TABLE IV-16

Extent to Which the Training at CIMMYT had Made a Difference in the Trainees' Ability to Help Solve Agricultural Problems

Change in ability	N	%
Little or no difference	15	11.6%
Some difference	51	39.5%
Important difference	63	48.9%
Totals	129	100.0%
Number not responding	1	

do the job." All of these reasons appear to be very consistent with the objectives of the CIMMYT Wheat Training Program as described earlier.

In summary, it is apparent that former CIMMYT Wheat Trainees are generally satisfied with their their previous training experience in Mexico. While some trainees feel that the level of training may be a little elementary for them, this response was expected, due to the diverse educational backgrounds of trainees. This problem could be resolved either by setting minimum educational requirements or by following the suggestions of some trainees by splitting the group into parts. While setting a minimum educational level of a B.S. degree would be the easiest way for CIMMYT to solve this problem, it may not be a desirable or feasible approach. As the FAO Wheat Consultant indicated earlier (see p. 107), it may be necessary for CIMMYT to take trainees with less academic training for several years in the future, to

keep some nations from falling too far behind other national programs in the region. Therefore, until potential trainees are available with the minimum educational backgrounds, it may be necessary to split the program into two groups, if this problem is to be resolved.

The only other deficiency which trainees emphasized in their direct feedback on the training program was the failure to spend more time on certain pathology and cereal technology procedures that are being covered rather briefly at the present time. Again it is doubtful that many of these trainees will use these skills after returning home; but, since it is an area of common concern to a number of trainees, it would seem warranted for CIMMYT to take the necessary steps to meet these needs.

Post-Training: The Types and Level of CIMMYT Contact with Former Trainees

As mentioned in Chapter II, the training institution can do much to help trainees translate new skills and knowledge into new behavioral patterns once back home on the job. This support may range from as little as just letting the trainee know that CIMMYT is still interested in what he is doing and hasn't forgotten him,[6] a fully developed cooperative program that involves local CIMMYT staff, with material and financial support. The purpose of this section is to give a general picture of the types and amounts of follow-up contact individual trainees have received from CIMMYT

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[6]See section on maintaining induced behavior through "identification" in Chapter II, pp. 56-57.

officials and representatives since returning home.

Correspondence

Trainees were asked if they had written to and had received letters from CIMMYT staff members since returning home. Fifty percent of the former trainees indicated that they had written to CIMMYT staff members and the average number of letters written per trainee since returning home for this "corresponding" group was 6.5 letters. Approximately 54% of the respondents indicated that they had received letters from CIMMYT headquarters, with slightly over six letters being the average number of letters received by each trainee.

Visits

Next, trainees were asked if they had been visited by a scientist or official from CIMMYT headquarters since returning home. Out of the 118 trainees who responded to this question, 40 (34%) indicated that they had never been visited since returning home. Among the 78 trainees who had been visited, the average number of visits per trainee was 3.3 visits.

Seventy-two trainees indicated they worked in national programs where a CIMMYT wheat improvement specialist was assigned. This group was asked to indicate the number of times during the past year (1972) they had been visited by this CIMMYT representative. The average number of visits for this group was 4.2 visits. In fact, this figure is biased somewhat downward; for,

in many cases, the CIMMYT wheat specialist works side by side with the former trainees.

CIMMYT Publications

One of the easiest communications mechanisms by which CIMMYT can inform former participants of new developments in wheat improvement is through CIMMYT's publications. These publications consist of newsletters, annual reports and research papers. The number of former trainees receiving information and support through this mechanism, however, has been somewhat low, with only 61 respondents indicating that they have been receiving publications. Of the other 68 respondents, thirty said they were not on CIMMYT's mailing list, with another thirty-six respondents being unsure whether they are still receiving publications from CIMMYT. It should be noted that all respondents in this survey have been included on CIMMYT's mailing list, unless they were no longer interested, therefore CIMMYT publications should now be reaching most former wheat trainees.

International Cooperative Trials and Nurseries

Trainees were asked if their national wheat improvement program had received any international cooperative trials or nurseries during the past two years. One hundred and twelve respondents (87.5%) indicated that such trials or nurseries had been received at their local experiment stations. Only nine trainees indicated that their local experiment stations had not

received such genetic materials within the past two years; while another nine respondents didn't know if such trials or nurseries had been received.

Post-Training Workshops

CIMMYT, cooperating with FAO's Near East Wheat and Barley Improvement Program and with The Rockefeller Foundation, has participated in three follow-up workshops for former CIMMYT/FAO trainees. Approximately every 2 years former CIMMYT trainees who were sponsored by FAO are brought together for a 7-10 day workshop. These workshops bring trainees up to date on new developments in wheat improvement, and participants hear progress reports from each national program. In addition, the group usually spends several days touring and observing the wheat improvement program of the national team, serving as host for the workshop. Thus far, workshops have been held in Pakistan, Turkey and Iran.

These workshops serve to strengthen regional cooperation among national programs and, in effect, function as an ad hoc professional group for wheat improvement workers in the Middle East. These workshops stress the development of new, improved wheat technology, and national wheat improvement teams use these workshops to pick up new ideas in reaching these goals, as well as to compare their own programs with others in the region. Since the national programs are in the spotlight at these workshops, each national wheat improvement team is stimulated to continue building

and improving its own program.

As mentioned above, these workshops have been generally limited to FAO-sponsored former CIMMYT trainees from the Middle East; therefore, only 55 respondents (43.3%) indicated that they have attended such workshops in the past. Of this group, 29 trainees have attended one workshop, 14 have attended two such workshops and 12 have attended all three workshops.

Use of Training

Generally the CIMMYT Wheat Training Programs can be considered as very "job specific." If the trainee returns to the type of job that he was trained for; then, it would be expected that he would make full use of his training experience. As will be shown in Section V, however, trainees do not always return to the jobs they expected to return to; or, other factors modify the extent to which the trainee is able to use his training in his job assignment. In this section, the purpose is simply to examine the major dependent variables in this study that characterize various aspects of the trainees' use of the training.

The Trainees' Self Assessment

Trainees were asked to assess how much of the training they were able to use during their first year on the job after returning to their home country. These data follow:

TABLE IV-17

Use of Training by CIMMYT Trainees During the First Year on the Job

Level of Use	N	%
Little or No Use	11	8.6%
Some Use	59	45.7%
Full Use	59	45.7%
Totals	129	100.0%
Number not responding	1	

Later, trainees were asked to assess the extent to which they are using the training in their present job, the purpose being to determine if the training became less relevant and useful to the trainees' job assignment as time passed. These data follow:

TABLE IV-18

Use of Training in CIMMYT Trainees' Present Job Assignment

Level of Uses	N	%
Little or No Use	8	6.4%
Some Use of Training	59	47.2%
Full Use of Training	58	46.4%
Totals	125	100.0%
(Number not responding = 1; Student = 4)	5	

While it may appear, in examining the two tables, that the level of training use has been extremely stable for the group, this is not entirely the case. While the total number of respondents in each category has remained nearly the same, there has been some movement of trainees between categories. By cross-tabulating the two variables it was found that some trainees who were not able to make use of their training in the first year have now moved into positions where they can make some (5 respondents) or even full use (2 respondents) of the training. In other cases, trainees have moved to new assignments where the level of use has declined.

Trainee Job Assignments as an Indicator of Level of Training Use

In considering the trainees' self assessment of their use of training, it is impossible to differentiate between direct and indirect use of training. For example, there were some respondents who were trained to do field research work, but who have now moved into jobs such as teaching plant-breeding or managing a research station. Some of these respondents indicated that while they are not working directly in field research work in wheat, they are still making some or even full use of their training. In these cases it is assumed that the use of training is indirect, rather than direct. While any use of training is considered to be desirable and preferred to no use, the direct use of training is considered to be more desirable than indirect use, because of the institution building perspective being used in this study. In other words, the impact

and use of training--as an institution-building tool--is taken to be largely dependent on trainees doing what they were trained to do. In this section the use of training will be assessed from the point of view of the direct use of training.

First Year on the Job After Returning to Home Country

Trainees were asked if they had returned to the job that they had expected before their departure. This information was tabulated with a second variable that indicated if this was the same type of job assignment the trainee had performed before coming to the training program. The objective being to determine if trainees returned to the jobs they had expected and if those were the same or different jobs than they had performed prior to the training experience.

TABLE IV-19

Job Returned to by Type of Job

Job Returned to	Same Job	Somewhat Different Job	Very Different Job	Totals
Trainee returned to the job he had expected	91	20	5	116 (89.2%)
Trainee did not return to the job he had expected	5	6	3	14 (10.8%)
Totals	96	26	8	130 (100.0%)
	73.9%	20.0%	6.1%	(100.0%)

As the data indicate, nearly 90% of the trainees are returning to jobs that they expected to be doing prior to departure, with the remaining trainees being subjected to unexpected personnel action. In this latter group a few trainees were transferred out of wheat improvement programs upon their return home; others to be assigned to a wheat improvement project after their technical training, were in fact returned to their previous jobs, possibly in an unrelated field. The vast majority of the trainees did return to their old jobs or expected new jobs presumably where their newly acquired skills could be utilized. The importance of job stability on the use of training will be examined more closely in Part V.

Present Job Assignment

Trainees were asked to give the descriptive title of their present job assignment, to determine if they are working in the skill area for which they were trained and if they are still working in wheat improvement programs. These data follow in Table IV-20.

These data indicate that a high proportion of former CIMMYT trainees are still working in the specific skill areas in which they were traineed--particularly wheat breeding, wheat agronomy, cereal technology and wheat extension. While a few trainees have been transferred to other crops, the movement to some type of administrative position has been the major problem area affecting the potential for the direct use of training. Even in some of these cases, however, there may be some indirect use of training.

Former trainees were asked to name the principal crops they work with in their present job. Ninety respondents (71.4%) indicated

TABLE IV-20

Present Job Assignments of Former CIMMYT Trainees

Job Category	N	%
Wheat Breeder	76	58.4%
Wheat Agronomist	12	9.2
Plant Breeder (other crops)	7	5.4
Wheat Pathologist	4	3.1
Cereal Technologist	6	4.6
Wheat Extension Specialist	5	3.8
Seed Certification (wheat)	1	0.8
Experiment Station Manager	4	3.1
Agricultural Research Technician	1	0.8
University Professor	1	0.8
Extension Administrator	1	0.8
Administrative Position (wheat improvement)	5	3.8
Other type of administrative position	3	2.3
Graduate Students	4	3.1
Totals	130	100.0%

that they only worked with wheat (and barley), while another 25 respondents (19.8%) worked with wheat and other crops. Three respondents said they only worked with other crops; another 3 said they no longer worked in any type of crop improvement program; with 5 former trainees failing to respond--but presumably are not working directly with wheat improvement at the present

time. The 4 graduate students could not respond to this question; but, it is likely that most will return to wheat improvement programs in their home country after completing their degree programs.

To conclude, it is apparent that a high proportion (91.2%) of former CIMMYT Wheat trainees are still working in some type of wheat improvement program, with 103 respondents (81.7%) working in those areas where they can make direct use of the training. Next some other characteristics of these trainees' job assignments will be described.

The large majority of former CIMMYT wheat trainees (103 or 81.8%) are still working with their national research organization, with another 8 respondents (6.4%) being employed by national extension agencies. Three respondents are still employed by an agricultural college or university, with 4 respondents moving into different organizations (business = 1, an international organization = 1, and other government organizations = 2). Eight Brazilian trainees are still working for the wheat cooperative (FECOTRIGO) in Southern Brazil that is sponsoring the wheat improvement program in this area.

To add some additional information on the descriptive job titles given previously, trainees were asked to describe the type of work involved in their present position.

These data on the type of work carried on by former CIMMYT wheat trainees reflect very closely the type of work assumed from the descriptive job titles given earlier.

TABLE IV-21

Main Type of Work Involved with CIMMYT Trainees' Present Position

Type of work	N	%
Mainly administrative	14	11.1%
Mainly field research	90	71.4%
Laboratory or Green House Research	8	6.3%
Mainly Field Extension	7	5.6%
Teaching or Training	2	1.6%
Some Combination of the above or other	5	4.0%
Totals	126	100.0%

Students = 4

Next, trainees were asked to describe the level of their current position within their work organization. The purpose of this question was to determine if former CIMMYT trainees are moving into leadership positions in their work organization. These data follow:

TABLE IV-22

Level of Present Job Within the Work Organization for Former CIMMYT Trainees

Level of Job	N	%
Policy Level	5	4.0%
Senior Level	52	42.0%
Middle Level	62	50.0%
Lower Level	5	4.0%
Totals	124	100.0%

Number not responding = 2; Students = 4

From this information, it would appear that CIMMYT trainees are moving into senior level positions in their work organizations; yet, most still are actively and directly engaged in wheat research activities. This information would tend to contradict what Wharton found among returning agricultural economists--i.e., that foreign-educated personnel quickly move out of active research positions into high level positions in program administration (Wharton, p. 12). It must be pointed out, however, that there are several important differences between these two groups of respondents, any of which may explain these different behavioral patterns. The important point to CIMMYT is not that former trainees are moving into more senior level positions (which generally implies increasing levels of administrative duties), but that they are maintaining active involvement in on-going wheat research programs.

Assessing Job Performance

One of the most important aspects of this study is to assess the effect of training on the job performance of each trainee. Because of time and size of population constraints, an independent supervisor evaluation was considered impossible. Therefore, the problem was to develop some type of objective measure of job performance which could be determined from a self-administered questionnaire. Since all three training programs had stressed some type of active research or production program, one series of questions dealt with the type and quantity of research experiments, applied research trials and production plots that each

trainee had worked on and helped complete during the last major wheat growing season in the trainee's country. The objectives in obtaining this type of behavioral data were three fold: (1) to determine if each former trainee was engaged in an active research/production program; (2) to determine the level of performance in these types of research/production programs; and (3) to determine which types of research/production activities were being given emphasis or priority by each trainee.

The type of data mentioned above, while being very valuable in determining which trainees are actually carrying out the type of activities they were trained to do, does not give any measure of improvement or change in behavior due to the training experience. Unfortunately, there was no way to obtain this type of pre-training data. However, while it was not possible to directly assess behavioral change within groups, this type of information should give excellent data for comparing behavior between groups. The objective being to determine if and to what extent different types of training programs have different effects on the work behavior of former trainees. These comparisons will be made in the final chapter. In this chapter, however, we will only consider the present work performance of former CIMMYT trainees.

Present Research, Development and Extension Activities of Former Trainees

As mentioned above, trainees were asked to indicate how many research experiments, applied research trials and production

plots they had worked on and helped complete during the last main wheat growing season in their country. Of the 130 respondents, 20 indicated that during the past year, they either had not worked in a wheat improvement program (7), were a graduate student (4) or were in an administrative or other type of position where they could not engage in these types of activities (9). Five respondents failed to answer the question. For the remaining 105 respondents, who had worked in a wheat improvement program, the actual number of experiments, trials and production plots were averaged for this sub-group to give a mean number/trainee.

TABLE IV-23

Mean Level of Research and Production Activities Completed By Those CIMMYT Wheat Trainees that were Active in Wheat in Improvement Programs During 1972

Type of Activity	Number & Percent of Trainees Conducting each activity (N = 105) N	%	Mean Level per Trainee (N = 105)
A. Laboratory or Greenhouse Experiments	13	12.4%	1.37
B. On Station Field Experiments	56	53.3%	5.62
C. Genetic Crosses	56	53.3%	227.1
D. On Station Replicated Applied Research Trials	65	61.9%	7.24
E. On Farm Replicated Applied Research Trials	44	41.9%	4.74
F. On Farm High Yielding Production Plots	37	35.2%	3.71

Approximately 91% of former CIMMYT Wheat Trainees are actively engaged in the types of activities they were trained to carry out (excluding the 4 graduate students). An examination of the preceding table gives a direct quantitative measure of the average work performance for these former trainees who are actively engaged in wheat research and production programs. In addition, it is possible to determine what types of research or production activities are being emphasized by former CIMMYT Wheat Trainees. Clearly, technology-development research activities[7] (types C, D and E) are dominating the research behavior of former CIMMYT trainees, with field research experiments also being given considerable attention. Since nearly 90% of CIMMYT trainees work for national research organizations, it was not unexpected to find that high yielding production plots (commonly viewed as an extension activity) were given less emphasis. It would be expected that in the future, as increasing numbers of wheat production workers are trained, the numbers of replicated applied research trials and production plots will be given increasing emphasis.

Level and Types of Contact with Agricultural Producers

It is assumed that CIMMYT is training research and production workers to help solve the problems of agricultural producers. To do this, research and production workers need feedback about farmer production problems (either through direct

[7] As defined by the functional model, which was developed in the first chapter, on page 15.

contact, or indirectly through extension workers). CIMMYT trainees were asked several questions to determine their level of direct contact with agricultural producers.

One hundred of the respondents (approximately 80% of the 125 former trainees presently working in their home country) indicated that they had direct contact with farmers during the past year. Of this group 45 trainees indicated that the majority of this contact had occurred on farms. Another 35 respondents indicated that their contact had been with farmers coming to the experiment station. The remaining 20 respondents indicated that their contact had mainly occurred at their office, at meetings or some combination of the above locations.

Next, trainees were asked to indicate the type of contact they had had with farmers.

TABLE IV-24

Types of Contact Former CIMMYT Trainees Have Had with Farmers

Type of Contact	Number of Respondents Answering: Yes	No	Total
(a) advising individual farmers on improved practices	72	28	100
(b) working with farmers by conducting production plots or field trials on their farms	50	50	100
(c) conducting field days and/or training programs for farmers	46	54	100
(d) organizing village/community meetings to advise groups of farmers on improved practices	36	64	100
(e) making radio reports, writing news reports, etc. for farmers	20	80	100

Number of trainees not having contact with farmers = 30
(of which 4 respondents were temporarily students).

To summarize, it was found that nearly 80% of former CIMMYT trainees are having some type of direct contact with farmers. The frequency of contact for most respondents was "several times per season" and the contact primarily occurred on farmers' farms and at the experiment station. Given the high proportion of research workers in the CIMMYT group, it would appear that most former trainees are having at least minimum levels of contact with farmers which would suggest a continuing interest in solving farmer production problems.

Assessing Research, Development and Extension Output

A common problem in evaluating research, extension and teaching personnel is to develop objective criteria by which an individual's work performance can be judged. As mentioned in the first chapter, this problem has been largely resolved for research workers in the industrially developed countries (particularly in the public sector--universities and government research organizations) through the use of an individual's publication record. This record is considered to be a combined measure of both quantity of research output (amount of research conducted) and the quality of output (i.e., the research must meet certain standards of the professional group to be accepted for publication. Unfortunately, no such objective measures are available to directly and regularly assess the output of developmental research workers, university teachers, trainers, or field extension workers. In these cases it is necessary to measure the level and types of work

conducted and to assume that certain minimum levels and standards of output are being achieved. Because of these reasons, the only output record that was obtained from the former trainees, and which is presented here, are averages (means) of the former trainees' publication record. Since the major work performance of former CIMMYT wheat trainees is in the developmental research area, these data should not be viewed as reliable measures of research output for this group.

Publication Record of Former CIMMYT Wheat Trainees

Trainees were asked to indicate if they had written any professional or technical papers or reports during the past two years (1971-72) for publication in a professional journal, for presentation at a professional meeting, for use by the national program or for use by agricultural producers. Sixty-four trainees indicated that they had published some type of paper or report. The following table summarizes the types of written materials produced during the past two years.

In conclusion, it is obvious that written publications and reports are not an important form of research output for former CIMMYT trainees. Only 50% (64 respondents) indicated that they had any type of written output, and within this group, the numbers of papers, reports, etc., produced during the two year period of 1971-72 appears quite low. This would again reflect the major types of research being conducted by these trainees. Therefore, to more adequately measure work performance, it is necessary to directly examine the amount and types of experiments, trials,

TABLE IV-25

Publication Record of Former CIMMYT Wheat Trainees During the Past Two Years (1971-72)

Type of Written Output	Number of Trainees Writing Each Type	Total Papers Written/ Published	Average Number/ Trainee
Technical Papers--for publication or presentation	39	101	2.59
Technical Reports--for internal use by the national program	41	114	2.78
Extension Bulletins, etc.--for use by agr. producers	15	29	1.93
Teaching materials, training manuals, etc.	9	17	1.89

Total Number of Trainees Reporting Some Type of Written Output: 64

crosses, production plots being completed. These data, which were presented in an earlier section, must become the primary dependent variables by which former CIMMYT Wheat Trainees can be evaluated and thereby be differentiated vis-a-vis performance and use of training. These data will be used in the following section to determine which factors are influencing the use of training.

Factors Influencing the Use of Training

This section will examine how different factors have affected the use of training, both during the first year after returning home from the training program and in the trainee's present job. First, an examination will be made of the effect of returning to a different job on the use of training during the first year. Next, an

examination will be made to determine the reasons why some former trainees are no longer actively engaged in wheat research and production programs and what these individuals are doing now. Finally, for those trainees who are still engaged in wheat research and production programs, a third perspective will be to examine specific organizational factors within the national program that may have limited their use of training; as well as to determine if any of these factors have directly affected work performance (amount of work completed).

Effect of Job Returned to on the Use of Training During the First Year After Returning Home

Since the CIMMYT training program is quite job specific, it seemed logical to expect that unless a trainee returned to the type of position (or work) that had been planned prior to his departure, his use of training during the first year would be reduced. As mentioned earlier, approximately 11% of the trainees had experienced unexpected personnel action after returning home. The following table will document the effect of these unexpected job changes on use of training during the first year.

As expected, the job-specific training that is given to trainees while at CIMMYT is not generally useful to trainees if they are assigned to a different type of position. For this reason, it is imperative that the work organization and the training institution are in close communication, so that a minimum of unexpected and unnecessary job changes occur, particularly during the first year or two after the participant returns home. Next, the reasons

TABLE IV-26

Effect of Unanticipated Job Changes on Use of Training During the First Year After Returning Home for CIMMYT Trainees

Job Returned To	Use of Training During First Year			
Returned to Expected Job	5	54	56	115
Returned to Different Job	6	5	3	14
Totals	11	59	59	129

N.A. = 1

$X^2 = 19.04$ with 2 df (P = .0001**)

why participants leave active wheat research and production work will be examined.

Reasons Why Trainees Are Not Actively Engaged in Wheat Research and Production Programs at the Present Time

Of the 130 respondents in the CIMMYT group, 20 trainees are not actively engaged in any type of wheat research and/or production work at the present time. Of these 20 respondents, four are temporarily in graduate school, and it is quite likely that most, if not all, of these participants will return to their respective national wheat improvement programs. A fifth trainee has been assigned to a wheat seed certification program, and is, therefore, directly involved in wheat improvement work, but not in a wheat research or extension position.

Of the remaining 15 trainees, seven are still actively engaged in field research work (plant breeding) but are working on other crops. Of this group, five were transferred by their work organization to meet manpower needs in these other plant breeding programs. These transfers were organizationally controlled and not prompted by the individual research worker. The other two research workers left wheat improvement work because of research opportunities and/or promotion that became available in another plant breeding program.

The other eight participants who are no longer actively engaged in wheat research and/or production programs are mainly working in administrative positions. Five of these participants carry on this administrative work within a wheat improvement program. Since these respondents are still associated with wheat improvement work, the reason for these internal job reassignments was not ascertained. Of the other three trainees engaged in administrative work, one left wheat improvement work for economic reasons, one became ill and had to shift to a desk position and one was transferred to this new position by his work organization.

Before leaving this section, there is an additional observation that should be made. Of the six trainees who were mainly involved in administrative type work prior to the training program, five continued to do administrative work after returning home. The implications of this observation are obvious vis-a-vis the selection of trainees. If CIMMYT is training wheat research

and production workers and expects them to actively engage in this type of work after returning home; then, they should be very careful about selecting administrative personnel for their future training programs. It should be recognized, however, that administrative officers can play a key role in supporting a national wheat improvement program; therefore, some type of orientation program may be necessary to encourage their help and support.

Limiting Factors to the Use of Training

Trainees were asked if there were any factors that may have limited their use of the training after returning home. The purpose of requesting this information was three-fold: (1) to determine which factors, if any, were more common to returning trainees, (2) from this information to determine what supporting role, if any, the training institution might play in helping to reduce the effect of specific limiting factors, and (3) to assess the influence of specific factors and the overall problem load of trainees on the use of training and actual work performance.

In attempting to determine the more serious limiting factors to the use of training, each respondent was requested to indicate if a number of different factors were a problem for him after returning home and if so, to assess this factor as being "somewhat of a problem," or a "serious problem" for him. To determine from these responses which factors were more troublesome for former trainees, "serious problem" responses were weighted by multiplying the actual number of responses in this category by a factor of 2 and

adding this to the number of "somewhat of a problem" responses. These data follow in ranked order, with the more troublesome limiting factors listed at the top:

TABLE IV-27

Limiting Factors to the Use of Training by CIMMYT Trainees (in ranked order of difficulty)

Limiting Factors: Lack of:	Number of Respondents indicating the limiting factor was: (N=130) somewhat of a problem	a serious problem	weighted total
Adequate budget	42	31	104
Laboratory or greenhouse facilities and equipment	37	30	97
Adequate transport	40	27	94
Adequate maintenance of equipment and facilities	38	20	78
Support from higher officials in the organization	42	18	78
Subordinates are inadequately trained	50	13	76
Authority to incorporate the training into the national program	32	14	60
Experimental land, field plot equipment, machinery, etc.	32	14	60
Essential operating supplies and materials	30	13	56
Support and help from trainee's supervisor	27	10	47
Interest from Colleagues to try new ideas and methods	19	7	33

As is true for most research workers around the world, the inadequacy of research funds was given as the most important factor limiting their use of training (as well as the size and scope of their research program.

The lack of laboratory and greenhouse equipment, which was listed as the second most serious problem, was not anticipated as being a serious limiting factor. The large proportion of CIMMYT research trainees were trained how to conduct a practical field research program and are, by and large, doing this type of work. Therefore, the question is asked, why would laboratory and greenhouse equipment be a major limiting factor to this group?

While insufficient empirical evidence was obtained which would directly support this explanation; it appears, both from the personal interviews carried out in the field and from other responses in the questionnaire, that screening early generation and advanced lines for cereal quality is of major concern to many of these participants. Acceptance of new varieties by farmers and consumers is dependent on satisfactory use qualities. Trainees apparently feel that the lack of appropriate laboratory facilities to supply this information is a serious limiting factor to their programs.

The lack of adequate transport ranks third as a serious limiting factor to the use of training and this would be linked to field testing of new varieties and production recommendations on farms. Conducting on-farm replicated trials and production plots requires that equipment, materials and personnel be transported throughout the wheat-growing region serviced by the particular

experiment station on a regular basis. The availability of reliable transport to carry out this type of work is a common problem to many experiment stations in LDC's as reflected by this response.

While most of these limiting factors are basically problems that must be resolved within national programs themselves, there are certain services that CIMMYT might provide to alleviate some of these difficulties. The problem of screening early generation and advanced lines for cereal quality appears to be one area that CIMMYT might take a more active role in solving. In particular CIMMYT has trained personnel and arranged for national cereal technology laboratories to be established in at least one country of every major wheat growing region of the Third World (in particular: Brazil, Ecuador, Tunisia, Lebanon, Pakistan and India). Unfortunately these laboratories are only serving the national wheat improvement programs of these respective countries. Rather than CIMMYT attempting to assist each nation in setting up a wheat quality laboratory, it would seem quite easy and expedient for CIMMYT to provide up to 50 or 100 kilograms of airfreight allowance (i.e., to cover the hard currency costs) for these smaller programs to send their materials to a regional laboratory for testing. This would certainly help resolve, in the short run, this serious limiting factor to many smaller wheat improvement programs.

While certain limiting factors may be more frequently mentioned by former trainees than others, this does not necessarily imply that any single, group or total number of factors plays an important role in reducing the effectiveness of wheat

improvement workers. To determine if any factor or group of factors was directly influencing use of training and work performance, multiple linear regression analysis was carried out. Prior to discussing the results of these analyses, it is necessary to digress briefly to indicate the type of dependent variables used in the regression models.

A composite measure of "use of training" as a dependent variable was constructed by adding assigned values for the variables "use of training in the first year after the training" with "use of training in the present job." A measure of work performance was developed by constructing a composite equivalency scale based on the actual number of research experiments, replicated trials, genetic crosses and production plots completed during the last main wheat growing season.

The regression analysis was approached from two perspectives. First the potential limiting factors, that were listed in Table IV-26, were included as independent variables in regression equations to determine if they could predict the value of either dependent variable. The results of these analyses were that none of the limiting factors had any predictive power over either dependent variable, with the exception of the variable "lacked authority to incorporate the training into the national program" on the dependent variable "use of training." In this case the relationship was statistically significant, but the amount of variation explained was very small. Nevertheless, this information was used in a second set of regression models developed.

The second attempt to develop a predictive model for the variables "use of training" and "work performance" was to take what information had been learned throughout the study and to include in a regression equation those factors that appeared to be associated with the dependent variables. The independent variables included were: (1) education level of the trainee prior to entering the training program, (2) whether or not he returned home to his expected job, (3) whether or not he lacked authority to incorporate the training into the national program, and (4) a combined assessment variable, including the variables (a) assessed level of skill competence achieved and (b) assessed level of increased ability. The results of these analyses were that the models did have predictive power over the dependent variables (i.e. the equations were statistically significant), but the level of that power (i.e. the amount of variability explained) was very small. Because these models have little predictive power, they are of no practical value to CIMMYT and therefore are not included in the thesis.

To conclude this section on regression analysis, the following postscript seems appropriate. It should be obvious to the reader that this study deals with a somewhat heterogeneous group of research workers, whose behavior is influenced by a number of different and, in many cases, unique factors. To attempt to predict work behavior and/or the use of training through the use of rather simple models, such as those presented above, would be wishful thinking at best. What was learned is that the independent variables included in the models do have a direct and consistent

influence on the dependent variables. What these models lack is explanatory control over the many other variables that are influencing work behavior and the use of training. Even knowing this additional information, however, there is still the unanswered question as to how much control CIMMYT has, as a training institution, over these explanatory variables.

Summary and Conclusion

The wheat training program in Mexico is an integral part of CIMMYT's overall outreach program to make available improved wheat technology to farmers in all major wheat growing regions of the Third World. Strong national programs are an essential part of this international wheat improvement strategy, both in the process of developing and disseminating improved wheat technology, and also in dealing with the technological spin-off problems (primarily disease epidemics) that are a potential threat to the precarious food balance in population dense nations.

When the wheat revolution began to spread beyond Mexico in the early sixties--particularly to South Asia and the Middle East--national wheat improvement programs in these areas were by and large weak and poorly organized. Training programs were used by CIMMYT to upgrade the technical skills of research personnel in the process of building strong, independently functioning national programs that are interdependent on other national programs and CIMMYT for new genetic resources and technical information.

At all levels, CIMMYT stresses a "team" or integrated approach to wheat improvement. At the program level, the emphasis is on interdisciplinary teams that are well integrated in function. At the international level, the national programs and CIMMYT work together as part of an overall International Wheat Team to share superior germ plasm and new varieties as soon as they are developed, as well as technical information on these genetic materials.

The major thrust of CIMMYT's training programs is (1) to teach the research skills and methods needed to operate a highly organized and efficient research program and (2) to give practical experience in integrating or combining genetic (and production) factors to create new genetic lines (and production recommendations) and in using selection criteria and techniques to evaluate and develop improved wheat technology.

In addition to these cognitive and psychomotor objectives, attitudinal change is also a central objective of the training program. The stress here is on serving the needs of agricultural producers by developing improved wheat technology and to do this by using a team approach. It appears that trainees tend to identify with the CIMMYT approach in general and with Dr. Borlaug in particular and feel that they are an integral part of this international wheat team. Because of the continuing contact and cooperation between CIMMYT and these national programs, trainee identification with these new professional values soon results in the internalization of these values by the trainees. Finally, after

a critical mass of CIMMYT-trained personnel is reached in the national program, it is expected that these new professional values become part of the normative structure of the national wheat improvement program.

The results of this training strategy find approximately 82% of former trainees still actively engaged in wheat research and production activities, with another 8% indirectly or partially involved in wheat improvement work. Only about 10% of former CIMMYT Wheat trainees are no longer working in wheat improvement programs.

The work performance of those former participants still actively engaged in wheat research and production programs is high (as measured by the numbers of research experiments, replicated field trials, genetic crosses and production plots completed) and emphasizes developmental, as opposed to experimental, research--particularly in the area of genetic technology. It appears that the work behavior of CIMMYT trainees, once back home on the job, is quite consistent with CIMMYT's training objectives. While there are certain training procedures that could be improved upon (see the next section on recommendations), it is the conclusion of this study that CIMMYT's training strategy has been quite successful in achieving the desired effect on the work behavior of its former participants. Given the type and amount of research completed by these former trainees, it would appear that strong national wheat improvement programs are developing as a result of this institution-

building strategy.

While CIMMYT appears to be very effective in producing research workers who can develop improved genetic technology, this success has not yet been realized in producing the other half of the wheat improvement team who can develop the complementary package of practices. This weakness probably stems from the fact that the CIMMYT research program concentrates on widely adapted genetic technology--with production technology being viewed as a location-specific problem. While this may be true, the fact remains that wheat production agronomists are sorely needed in most national programs to fully exploit the production potential of the superior varieties that are being developed and released to farmers.

To emphasize this need, in one country, it was found that the nitrogen-phosphorus ratio--as originally recommended by the national program--was so badly out of balance that the Mexican varieties were thought to be degenerating genetically. In fact, they were only suffering from phosphorus deficiency. This is an excellent example of production recommendations being based on inadequate production research and on farm field trials. Now as the improved varieties move beyond the irrigated fields into the higher risk, rainfed areas, production recommendations and cultural practices must be carefully developed and well tested to fully exploit this new genetic technology, while minimizing risk to the agricultural producer as he increases his use of capital inputs. The production half of wheat improvement teams in many national programs are quite weak and are receiving

inadequate attention by CIMMYT. CIMMYT needs to give considerable attention to this serious technical manpower problem and should develop a complementary training strategy to meet these needs. Once this is done, then adequate resources must be made available to get on with the job.

A Recommendation for Improving the Existing Wheat Improvement Training Program

The on-the-job training approach used in the wheat breeding and improvement training program has been very effective in preparing wheat research workers to operate similar wheat improvement programs in their home countries. What has been lacking within this overall training effort is a more adequate theoretical input to complement the existing practical field training. One reason that may explain why this theoretical input has never been effectively handled by CIMMYT is that there are two distinctly different educational needs being articulated by training participants. It would appear that a certain amount of confusion has resulted in attempting to meet these needs, because these two problems have tended to be considered as one. The following discussion will attempt to clarify these educational deficiencies and how CIMMYT might proceed to remedy the more serious of the two problems.

The main problem concerns those trainees (particularly those with less than a B.S. degree or its equivalent) who lack even the most basic background in plant breeding and genetics, as well as training in agronomy, soils and plant nutrition,

pathology, entomology, etc. To help provide these trainees with the minimum necessary theoretical background in these technical subject matter areas, CIMMYT has held remedial sessions (which all trainees have been required to attend) during the first months of the training program. The results of this approach have never been very satisfactory. First, it must be recognized that a couple of hours of classroom instruction for 8 or 10 weeks, with little time for reading and study, is just not adequate to meet the theoretical background needs of trainees with only secondary or post-secondary school training in general agriculture. Second, is the common problems associated with on-the-job training which results in conflicts between training and production goals (i.e. classroom instruction versus getting out in the field and helping to carry out the research work). Finally, for those trainees with relatively strong academic backgrounds in these technical subject matter areas, these remedial sessions are generally too elementary for them (see page 143) and their time might be better spent in the field gaining direct experience in the CIMMYT research program.

A possible solution to this problem would be to send those trainees with inadequate theoretical training (primarily trainees from North Africa) to a university (such as the American University of Beirut, or a university in the U.S.) where they could take a semester of basic course work in these technical areas. Also, since many of these same trainees have limited backgrounds in English, this academic training would help increase their English competency before entering the training program in Mexico.[9]

Then, after completing a semester (September-January) of academic training, these trainees could proceed directly to Mexico for the start of the regular CIMMYT training program. This approach should largely eliminate the need for the remedial theoretical training that CIMMYT is not really prepared to provide; and, in addition, it should put trainees on a more nearly equal theoretical level, thus eliminating the need to split the trainees into two groups (as discussed on page 143). Finally, the timing of this supplemental academic training should not cause any additional disruptions to the national program than are presently caused by the regular training program.

The second educational deficiency, which has been dealt with more adequately by the CIMMYT research staff during the last 2 or 3 years is providing trainees with a better theoretical understanding as to why different research methods and procedures are used, how evaluation parameters (decision criteria) were developed, etc. In other words, through on-the-job training trainees learn and gain extensive field experience in how to run a wheat improvement program. In many cases the research procedures which make up this program have been worked out during years of trial and error in the field. Frequently they are based on insights about breeding methods or about the wheat plant that the trainee will never find in a research paper or in a text book. CIMMYT has made a good

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[9]Note: most universities offer remedial English classes for foreign students which these trainees could also take.

start in making this information available to trainees in the form of the Wheat Breeding Training Manual. These efforts to organize and write down the theoretical rationale for different aspects of the CIMMYT research program should be continued and expanded by appropriate members of the research staff.

CHAPTER V

THE RESEARCH AND OUTREACH PROGRAMS OF IRRI

Introduction

Two of IRRI's training programs were selected for study in this research. These programs are the Research Fellow-Scholar Training Program[1] and the Rice Production Training Program. Both of these programs had a sufficient number of participants, program continuity, and length of operation to allow a participant follow-up study. Other trainee groups, such as those in multiple cropping and the rice experimentation workshops, were not included in this study.

The research training program is closely tied to IRRI's on-going research program where individual trainees are assigned to work directly under a senior scientist--generally on some aspect of his overall research program. The rice production training program is primarily for extension personnel. The aim is to "train the trainer." Trainees participate in a formally organized training program aimed at teaching all phases of modern rice production.

Before considering these two training programs in detail, it will be useful to first examine briefly IRRI's research and

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[1]Hereafter referred to as the Research Training Program.

outreach programs. It has been this investigator's experience that some individuals not directly familiar with the operations of the different international research centers tend to equate the structure and function of these centers. Since these two factors directly influence the trainees' perception as to how an effective research organization operates, the following sections will attempt to highlight some of the distinguishing features of IRRI as observed by the investigator.

The Objectives of IRRI

> The International Rice Research Institute, chartered in the Philippines in 1960 and inaugurated 1962, was charged by its founders with the responsibility of finding ways to increase rice production in the tropics. Implicit in this charge was a recognition that IRRI's success could truly be measured only by the extent to which rice production actually increased in the region. (McClung, 1972, p. 3)

To carry out this broad objective of increasing rice production in the tropics, IRRI is organized around three basic functions: research, training and international extension. "The research program was initiated first, but the international training and extension activities increased rapidly as soon as it became apparent that there was research worthy of extension" (Barker, 1971, p. 3).

All of these programs and activities have been described in detail elsewhere (see the IRRI Annual Reports, as well as the IRRI publications: Rice, Science and Man and Rice Research & Training in the 70's). The reader is directed to these sources for more first hand information about these programs.

The Research Program

Functional Aspects of the Research Program

IRRI's research program represents a well balanced research effort focusing on the important limiting factors of rice production at different levels of investigation. The institute is organized around disciplinary departments. While there is cooperation and collaboration among research workers, observers report the following functional character: "Each staff member is responsible for the development and administration of his own particular research program" (Barker, 1971, p. 4).

While CIMMYT's research program can be characterized as a crop improvement program emphasizing genetic technology, IRRI staffers pointed out (to this investigator) that their organization is a "research institute." Thus while IRRI carries on "technology developing" research aimed at provoking new improved varieties of rice: "...the institute will not hesitate to undertake basic research if it is designed to collect information needed to answer questions that are limiting progress of rice production research" (Athwal, 1972, p. 41).

IRRI's international reputation is largely based on its most significant research contribution during the sixties: the development and introduction of new genetic technology for the tropics in the form of a new type of rice plant:

> IRRI's breeders knew from the start that they needed a short variety with strong stems so that it would not fall over when high rates of nitrogen were applied.

> If the plant did not fall over it would use the nitrogen to produce plumper grains and more of them.
>
> The breeders found such a tropical semidwarf variety in Taiwan. It was called Taichung Native 1.... The source of the semidwarf stature of Taichung Native 1 is a variety called Dee-geo-woo-gen. In 1962, the first year of research at IRRI, the breeders made 38 crosses.... One of the crosses was between Peta, a traditional Indonesian variety with good insect and disease resistance, and Dee-goo-woo-gen. Three years later, an experimental variety selected from this cross produced a computed yield of 6.6 metric tons per hectare. The following year IRRI named it IR 8. The green revolution in rice had begun....
>
> IR 8 went round the world and showed its high yields to everyone. It made believers out of farmers, scientists, and national leaders. It made them believe that rice production could be radically changed. It made governments believe giving agricultural scientists good financial and organizational support could pay handsome returns to the national welfare. (IRRI, "IR8 & Beyond," pp. 3-4)

Since IR8 was released in 1966, five additional varieties have been named and released directly by IRRI (IR5 in 1966, IR20 and IR22 in 1969, IR24 in 1971 and IR26 in 1972); with another 19 IRRI selections being named and released for commercial cultivation by different nations (IRRI Annual Report for 1972, p. 1).

While the acreage planted to high yielding varieties of rice had reached 25 million acres (about 9% of the world's total rice area) by 1970-71 (Dalrymple, 1972, p. 47) the genetic technology is the result of a very small investment in terms of financial and staff resources. While this genetic breakthrough is the result of years of research by many different scientists in several different countries, the varietal improvement program of IRRI has never exceeded three scientists, with only two of these staff members

functioning as full time plant breeders. Other IRRI scientists, such as the plant physiologists, pathologists and entomologists, contribute to this process of developing new genetic technology--by identifying new sources of resistance, new screening techniques, etc. But within the IRRI research structure, it is the plant breeders that are directly responsible for combining and recombining different germ plasm to develop the new genetic technology.

While developing improved genetic technology is one important function of IRRI, it would appear that in terms of staff time and research expenditures the major thrust of IRRI's research work is designed to answer those questions (i.e. knowledge generating research) that are limiting the progress of rice production research (i.e. technology developing research). As pointed out in an earlier chapter, research aimed at developing "production technology" (i.e. a package of practices to exploit existing genetic technology) is considered to be quite "location specific." Therefore, IRRI scientists cannot develop or recommend production practices that would be appropriate for most other parts of the Philippines, let alone South and South East Asia. Instead IRRI scientists, in helping to solve many of these rice production problems, work at the next higher level of generalization to generate knowledge that will enable national programs to solve their production problems.

While IRRI has received most of its public attention and recognition for the development and dissemination of the "miracle rice" varieties for tropical Asia, its scientists are well known

within the international scientific community for their contributions to the body of knowledge within a number of different agricultural disciplines. As the former Director of IRRI, Dr. Robert F. Chandler Jr. points out, "At any scientific meeting that involves rice there is an IRRI scientist to present a paper of high quality. This applies everywhere, not only throughout Asia, but in Europe, the Americas, and Australia as well." Chandler goes on to say that, "It has been our general policy to hire fairly young scientists, who in their eagerness to establish their reputations in their own professional fields have established and furthered the reputation of the institute" (Chandler, 1972, p. 16).

This policy has, in fact, been very successful in that IRRI scientists have been very prolific in their contributions to the growing body of knowledge about rice production in the tropics. While the permanent senior research staff of IRRI has never exceeded 18 scientists (Barker, 1971, Table 2) the number of staff publications, as listed in the Institute's Annual Reports, averaged 50 publications per year for the years 1968 through 1971 and in 1972 IRRI scientists produced or contributed a total of 80 technical papers. This is a remarkable achievement for a research institute that initiated its first research experiments only 10 years earlier.

In addition to what might be called IRRI's core research program focusing directly on increasing rice production, the institute is also involved in research on multiple cropping and agricultural engineering. The multiple cropping program focuses on the development of intensive food production systems that center

on rice, but that include other crops to both increase total food output as well as to improve the nutritional quality of the diets of rural families--especially the diets of the children. The agricultural engineering department develops simple, low cost machinery for the small rice farmer, particularly when growing the high yielding varieties of rice. The lack of labor at critical points in the growing season can also become a limiting factor to increased production. Therefore, the specific objective here is to provide specific types of small scale machinery that will break through these production bottlenecks.

A final research effort that should be mentioned here is the applied research trials that are being conducted in two provinces of Central Luzon by the Rice Production Training and Research Program. This research work is part of a three year cooperative project between IRRI and several Philippine agencies. In particular this is a rainfed and upland rice research project that is designed to test high yielding varieties under rainfed conditions and to develop and extend an improved package of practices for rice production in this area.

The Research Structure of IRRI: A Coordinated Multi-Disciplinary Team

As mentioned in the previous section, IRRI is organized by departments on the basis of disciplines. Dr. D.S. Athwal, Associate Director of IRRI, points out, however, that "...most of the research work involves a team approach based on interdisciplinary

cooperation" (Athwal, 1972, p. 41). While interdisciplinary cooperation among scientists is apparently common, it should be made clear that these joint research efforts do not result from the formal organizational structure of IRRI. Barker suggests how this interdisciplinary collaboration between scientists occurs:

> Interdisciplinary research is not normally organized by creating interdepartmental projects. However, the small size of the senior staff, and the comparatively narrow focus of the research objectives facilitate communication between disciplines. Through personal and professional contacts, scientists in one field of work become familiar with technical problems in related fields. As a consequence, the direction of research in each of the departments tends to be influenced more by the interaction with colleagues at the Institute than with colleagues in the same professional discipline. (Barker, 1971, p. 4)

The interaction between colleagues that Barker refers to is facilitated through both formal and informal mechanisms. Certainly the "Saturday Seminar" represents an effective communications mechanism by which research progress and results are transmitted both to trainees and to other members of the staff. In addition, this investigator observed that the morning and afternoon coffee breaks represented a key informal communication mechanism during which new ideas were "sounded out." Sometimes these discussions resulted in follow-up meetings and the exploration of possible joint collaboration on projects. Finally the fact that the senior staff live in a housing compound and thereby frequently socialize together, would also result in considerable informal, yet professional interchange among colleagues. While this system works well for IRRI, given the unique circumstances of this research

organization, it must be recognized that it is largely the informal rules and not the formal organizational structure that facilitates interdisciplinary research efforts. The same organizational structure, placed in the context of a national program, may produce entirely different types of programs and results. Generally the structure (disciplinary), function (both knowledge generating and technology developing) and focus (single commodity--rice) of IRRI represent what this author would suggest as a good example of a multi-disciplinary research organization.

International Outreach Programs

Through its international activities, IRRI is concerned about building strong national programs. Its strategy in doing this, however, differs rather distinctly from that followed by the CIMMYT Wheat Program. This section will attempt to clarify IRRI's institution building strategy, which will be followed by a short statement describing each of the important outreach activities of IRRI.

IRRI's Institution Building Strategy

It appears that IRRI, as a research organization with top scientists and excellent resources, has had a continuing concern about dominating the efforts of national programs. A. Colin McClung, former associate director of IRRI and the administrator in charge of international activities, had this to say about the cooperative programs between IRRI and national programs:

> The basic philosophy of these agreements was quite clear on an important point: they were in no sense intended to lead to the establishment of branch stations of the International Rice Research Institute. Rather, they were designed to foster improvements in the host countries' research and development programs. The degree and pace of IRRI's involvement would be set by the decisions of local authorities... (McClung, 1972, p. 28)

This policy statement appears to be generally operative in all of IRRI's international activities. For example, staff members indicated that they have to be formally invited by a national program before approval is given for a consulting visit. Likewise IRRI responds to individual requests for germ plasm, technical information, etc. and has not become actively involved in establishing regular, on-going systems for the exchange and dissemination of germ plasm. And, as will be discussed later, IRRI does not dictate the type of training that will be given to research trainees from national programs. Instead, the trainee or his national program makes a specific request for a particular type of training and IRRI, in turn, responds to this request. If IRRI is working in this particular research area, can accommodate the trainee, and if the trainee meets other selection criteria, then he is accepted.

To conclude, it would appear that IRRI's institution building strategy has been largely one of responding to specific requests by national programs. In most cases the national program decides what assistance is to be provided and then IRRI uses whatever resources it has available to meet these requests. IRRI does not appear to take an active role in building a specific research function into a national program. Instead, IRRI's more broad

research objectives tend to be reflected through its international activities, rather than concentrating on a specific research problem (such as varietal improvement, as is the case in the CIMMYT Wheat Program).

Germ Plasm Exchange

IRRI has made a concentrated effort to collect and maintain the largest germ plasm bank for rice cultivars in the world. Each year IRRI sends thousands of seed packets around the world in response to requests.

Major Symposia and Rice Research Conferences

During the early years of the institute's operation six major symposia were held dealing with the following research areas: rice genetics, plant nutrition, the rice blast disease, rice entomology, virus diseases of rice, and rice breeding. By bringing together the top rice scientists from around the world, IRRI scientists were able to assess the current state of rice research work and thereby focus the institute's research on key problems limiting rice production throughout the tropics while avoiding a duplication of effort.

Since then IRRI has sponsored annual international rice research conferences which are attended by Asian rice research workers.

> These conferences are essentially working meetings which deal with current research problems. Usually two or three major subjects are covered. For example a particular meeting, 4 or 5 days in length, may deal with breeding, pathology, and entomology.

> The conference the next year may cover soils, agronomy, and physiology. The conference is built around the work of the participants in these fields and serves as an excellent place to exchange information and plan cooperative work. (McClung, 1972, pp. 38-39)

Technical Information and Documentation Center

IRRI's library has compiled an extensive literature on all aspects of rice research work that have been published around the world. This literature is available through a photocopy service to rice scientists who request it. In addition, IRRI publishes and distributes The International Bibliography of Rice Research, to rice researchers and libraries. The publication has documented nearly all of the rice research literature published since 1951.

Finally IRRI publishes all of its important research findings in its own technical reports and each year a comprehensive technical annual report summarizes research findings and progress made by each department. All of these sources of technical information and research results help keep rice research workers, particularly in the tropics, up-to-date and abreast of the latest developments in the field.

International Cooperative Programs

IRRI has entered into a cooperative working relationship with a number of national rice research programs in Asia. In cases where long term involvement is anticipated, a formal agreement is entered into by IRRI and the national program, along with a third donor agency that is willing to finance IRRI's

participation in the project. In all cases, the long-term objective of these cooperative programs is to increase the research capability of the national program while at the same time utilizing improved rice technology from IRRI and other external sources to rapidly increase rice production in the short run.

IRRI leaders have expressed a sensitivity and concern that their international activities do not dominate the research capability of the national program (See McClung, 1972, p. 38) and that national programs do not become dependent on outside sources for their rice technology (see McClung, 1972a, p. 4). IRRI's strategy in this regard appears to focus on two important points: first, that IRRI's role in these cooperative relationships should be largely that of a resource agency (resources being: training, germ plasm and high yielding varieties, research information, consulting by senior scientists, etc.); and second, that decisions regarding how these resources are used (i.e. the type and extent of IRRI's involvement) be left with the national program. By following this strategy, IRRI appears to be operating on the belief that each national program understands best which local agricultural problems need attention and in addition knows how to organize its scientific resources to resolve these national rice production problems. Thus IRRI "... has focused on the needs of each national group and has not tried to introduce a fixed pattern to all countries" (McClung, 1972, p. 37).

While the nature and extent of assistance given to each national program varies, in most cases IRRI assigns one or more rice scientists or production specialists to work directly with the

national rice research team. In addition, funds are allocated for training national research and extension personnel at IRRI or in foreign universities as well as to provide needed experimental equipment to establish effective research programs.[2]

IRRI's Training Programs

The training programs at IRRI are another important aspect of the institute's international activities. Two of these programs, the Research training Program and the Rice Production Training Program, make up the major thrust of IRRI's training activities and are the subject of the remainder of this study.

The research training program has fellows and scholars working in all of the disciplines represented at the institute. Again the strategy followed by IRRI is to offer a flexible program that will meet the needs and requests of national programs insofar as possible. Therefore, the main training objective within this program is to upgrade the technical proficiency of research personnel from these national programs, so that these research organizations can better achieve their specified objectives. Fostering directed organizational change through training does not appear to be one of the objectives of this particular training program; nor would such an objective be consistent with IRRI's expressed institution building strategy vis-a-vis national research programs.

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[2]For a summary of these different international programs, see Colin McClung's paper on "IRRI's Role in Institutional Cooperation" in Rice, Science and Man.

"Since June 1964 IRRI has operated a rice production training program to train rice extension personnel in the science and skills of producing rice" (Ross, 1971, p. 1). While the course content of this particular program covers all aspects of modern rice production, including practical field experience in growing a crop and in carrying out applied research trials, the expressed behavioral objective of the program is to "train the trainer." The idea is that since so many extension agents are needed in a national rice improvement program, it would be impossible for IRRI to train a sufficient number. Therefore, the idea is to train rice production specialists who, in turn, can develop and operate training programs in their own countries. This approach is expected to result in a substantial multiplier effect. While some national programs may have some type of in-service training programs for extension personnel, the IRRI approach probably goes well beyond local efforts. IRRI is attempting to initiate new or substantially different in-service training programs that will teach modern rice production practices to substantial numbers of extension personnel who are inexperienced in such skills at the present time.

Conclusion.

The research program at IRRI represents a balanced approach to investigating and resolving many of the limiting factors of rice production in the tropics. While IRRI's main public achievement has been the development and introduction of a new plant type (genetic technology) for tropical rice

production, another major thrust of the institute's research work is designed to answer those questions (knowledge generating research) that are limiting the progress of rice production research. This information, in turn, can be used by national programs to actually develop the production technology that is needed to resolve specific limiting factors.

The institution building strategy followed by IRRI appears to reflect concern for the problems of institutional domination and technological dependency. With the introduction of high yielding varieties IRRI did, in effect, create a condition of technological dependency. Therefore, IRRI's stated institution building strategy is "...to build local competence so that local problems can be attacked directly..." (McClung, 1972, p. 38). To avoid the problem of dominating national programs through its international extension programs, IRRI leaves decisions as to the type and level of institute involvement up to the national program themselves. In doing so, IRRI mainly serves these national rice research programs as a resource to be used in those ways that will best assist national research programs to achieve their own objectives. This approach assumes that each national research program knows where it wants to go and mainly lacks the technical, human, and/or financial resources necessary to achieve these goals. The validity of this assumption, when considering rice research programs throughout Asia, is certainly open to question.

With this overview of IRRI's research program and international activities, it is now possible to examine the objectives of

and the methods used in each of IRRI's two main training programs. The next two chapters will examine these two particular programs in detail.

CHAPTER VI

IRRI'S RESEARCH TRAINING PROGRAM

Introduction

Since IRRI opened its doors in 1962 it has been actively engaged in the training of young scientists. The research training program has two general types of participants: research scholars and research fellows.

Research Scholars

> A research scholar is usually a young, potential scientist who spends 1 or 2 years at the Institute to obtain experience and training in a general field of research under the supervision of a senior scientist in his field of specialization. (IRRI, "The Training Program," p. 5)

Research Scholars can be further categorized into degree and non-degree types of training programs. For the non-degree scholar,

> During the early period of his stay, he gains experience by serving as a research assistant to his advisor. Later, he is assigned to a definite research project which he conducts from the planning stage through final analysis and presentation of the report. Thus, he obtains firsthand experience in all aspects of a research project, always with the counsel and guidance of an experienced research scientist. (IRRI, "The Training Program," p. 5)

The institute encourages many of its research scholars to pursue a Master of Science degree at the College of Agriculture of the University of the Philippines. In these cases, the Research

must be acceptable to the College of Agriculture for graduate study and generally follows a year of formal course work at the College, combined with a year of research work at the Institute. Generally the thesis problem is integrated with the scholar's research project at the Institute. This arrangement is facilitated by the fact that all of the senior scientists at IRRI are members of the Affiliate Graduate Faculty of the College of Agriculture.

Research Fellows

> A research fellow is a relatively more experienced or better qualified scientist, usually a person with at least the Master of Science degree, or its equivalent, who comes to familiarize himself with some special field of study.... The research fellow works closely with a senior scientist in his field of specialization. He may undertake a short but intensive research project, using facilities which are not available in his station or country; develop or gain experience in a particular research technique; review research results of potential value to his home station; or pursue other activities designed to advance himself professionally, and, in so doing, contribute to research progress in his country. (IRRI, "The Training Program," p. 6)

Research fellows are further categorized into two groups: post-M.S. fellows and post-doctoral fellows. The post-doctoral program is for the scientist who has recently completed his Ph.D. degree, but who may lack experience doing production related research. Generally the post-doctoral fellow spends from one to two years at the institute conducting highly specialized research on problems that affect rice production.

The post-M.S. fellow follows a similar program approach as the post-doctoral fellow, but his research project is somewhat

less specialized and he works under somewhat closer supervision of an IRRI scientist. The length of training for post-M.S. fellows is generally of shorter duration than the post-doctoral fellow, ranging from 6 to 12 months.

Methodological Note

The data to be used in the evaluation and analysis of this program were derived from a mail survey questionnaire that was sent to all former research fellows and scholars who had successfully completed their training at IRRI. Before proceeding into the study itself, it appears useful to digress briefly to give the reader a general overview as to the number and types of respondents. For a more detailed description of the research methodology employed in this study, including copies of the data collection instruments, please see the attached appendix entitled: Summary of Research Methodology.

In determining which trainees should be included in the study, certain uniform criteria were established for all three training groups. First that the trainee be back home on the job at least six months prior to completing the questionnaire; second, that the trainee had successfully completed more than two months of active training at IRRI: and third, that the trainee be from a less developed country (note: trainees from Japan were an exception to this rule and were included). Using these criteria and after carefully searching IRRI's research training files, it was determined that 312 former research participants met this criteria. Of this

group, however, there was no current forwarding address available for 16 participants and a 17th trainee is deceased. Therefore of the 295 participants that had an opportunity to respond to the questionnaire, responses were received from 234 research trainees, representing an overall response rate of 79.3%.

As mentioned earlier there are four general categories for research trainees at IRRI. These categories are degree and non-degree scholars, and post M.S. degree and post-doctoral fellows. The following table indicates the number of respondents that are represented in each of these different categories.

TABLE VI-1

Number of IRRI Research Respondents by Training Category

Training Category	N	%
Non-degree Research Scholar	72	31.0%
M.S. Degree Research Scholar	76	32.8%
Post-M.S. Degree Research Fellow	57	24.6%
Post-Doctoral Research Fellow	27	11.6%
Totals	232	100.0%
Not Ascertained	2	

In the decade that IRRI has been conducting training programs for rice research workers, participants have come from 29 different developing countries. The following table indicates the number of trainees and respondents from each of these countries.

TABLE VI-2

Number of IRRI Research Trainees and Respondents by Country

Country	Number of: Trainees	Respondents
Japan	27	20
Korea	23	20
Taiwan	24	19
Fiji Islands	1	1
Philippines	71	54
Malaysia	3	2
Indonesia	12	10
South Vietnam	2	2
Khymer Republic	1	0
Laos	1	1
Thailand	37	21
Burma	4	4
Bangladesh	15	13
India	45	33
Sri Lanka	8	7
Pakistan	11	10
Nepal	2	2
Iran	2	1
Egypt	3	1
Sudan	1	0
Senegal	1	1
Guinea	1	0
Nigeria	6	6
Ghana	1	0
Cuba	1	0
Guyana	1	0
Colombia	5	5
Panama	1	0
Mexico	2	1
Total	312	234

Although the first research trainees began arriving soon after IRRI opened its doors, the first graduates were not forthcoming until the latter part of 1963. The following table indicates the number of IRRI research graduates per year among the respondent group.

TABLE VI-3

Number of IRRI Research Respondents Completing Their Training by Year

Year	N
1963	5
1964	31
1965	17
1966	25
1967	18
1968	24
1969	24
1970	33
1971	38
1972*	19
Total	234

*1972 data includes all graduates thru September of that year.

With this general introduction as to the types of training categories found within IRRI's Research Training Programs, it is now possible to examine IRRI's research training approach as a whole. The procedure to be followed in studying this approach will be the same as that used in the analysis of the CIMMYT Wheat Training Program, in that the training experience will be divided into the three stages of training. These stages are: (1) pre-training, (2) training and (3) post-training. The procedures and objectives associated with each stage of the training process will be discussed and survey data presented to further document these activities. The

final sections will deal with the use of training on the job after returning home and an analysis of those factors influencing the use of training and work performance.

Pretraining

The pretraining period includes the application and selection process. Where the institute has entered into a formal cooperative agreement with a national government, the institute frequently works through its local representative to identify and assess technical manpower deficiencies, and to work with national program leaders in screening and recommending individuals for different types of training at IRRI.

In cases where IRRI does not have a local representative, potential trainees may be identified by IRRI staff members visiting rice research programs in a particular country; they may be recommended by an official of another international agency; potential trainees may apply directly to IRRI; or they may be recommended to IRRI by the national government.

Selection Criteria and Procedures

Generally candidates for IRRI's research training programs are screened at two levels before being admitted into the program. After a candidate has been nominated by his government, or his name has been received by the institute as a candidate for the program, he is interviewed in his home country by an institute staff member or another qualified person designated by IRRI.

The purpose of this interview is to determine (1) if the candidate has the personal and intellectual qualities which appear necessary (as judged by the interviewer) for a successful research worker, and (2) if he meets the general qualifications specified by the institute. These general qualifications are that the candidate:[1]

1. Be a staff member of a research or educational institution concerned with rice;
2. Have a Bachelor of Science degree or its equivalent (for research fellows, at least the Master of Science degree or its equivalent);
3. Be recommended by the institution or organization where the candidate is employed;
4. Be assured a leave-of-absence from his employment during the period of training, and a position on his return;
5. Be in excellent physical and mental health.

Once the candidate meets the general requirements of the institute, his case is forwarded to the appropriate department within IRRI. At this second level of selection the area of concern is primarily technical. The candidate or his national program has proposed that he work in a particular research area or on a specific research problem. The department must decide (1) if it has adequate interest in his research area, (2) if adequate time and resources are available to work with a research trainee in this problem area and (3) if the candidate has sufficient academic background and/or experience to handle a research project in this particular problem area. If the department's response to these questions is affirmative,

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[1]IRRI, "The Training Program, p. 8.

then the candidate will be sent a letter of notification indicating that he has been approved for admission into the program.

Senior scientists at IRRI do occasionally identify candidates for research training while visiting national programs; but, based on interviews with IRRI staff members, it appears that the more common procedure is for each department to react to specific applications that come into IRRI from the national programs. The point that is important to note here is that the senior scientist does not appear to play an active role in identifying deficiencies in national programs, that could be strengthened through training. Rather, many of the scientists indicated that they generally reviewed these training requests from the point of view of resource availability and the relevancy of the proposed research problem to their own research programs. This again reflects the delegation of decision making, vis-a-vis institution building through training, to the national program.

Selection Criteria Used in National Programs

As mentioned earlier, there was considerable concern expressed by officials at one center to learn more about selection criteria and procedures used in national programs and to determine if and to what extent these factors affected the use of training and work performance of former trainees after returning home. Therefore, research trainees were asked to assess the importance of a number of different factors that may have been instrumental in their own selection.

TABLE VI-4

Assessed Level of Importance of Specific Factors Used in the Selection of IRRI Research Trainees (by the Participants Themselves)

Factors	Level of Importance: (N=234) Very Important	Somewhat Important	Not Important	Don't Know or N.A.
Needed the training to do my job more effectively	74.1% (143)	23.8% (46)	2.1% (04)	(41)
Educational Qualifications	65.3% (128)	29.6% (58)	5.1% (10)	(38)
Language Ability (English)	44.7% (80)	45.8% (82)	9.5% (17)	(55)
Member of an accelerated rice improvement program	42.2% (68)	36.7% (59)	21.1% (34)	(73)
Seniority--next in line for training	15.2% (25)	42.1% (69)	42.7% (70)	(70)
Good Relations with local IRRI Representative	10.2% (15)	20.4% (30)	69.4% (102)	(87)
Good Relations with Higher Officials in His Organization	5.8% (09)	27.3% (42)	66.9% (103)	(80)

As was anticipated, the factor most frequently mentioned by former trainees as being important in their selection was the training was needed for the job. Following this, however, educational qualifications and language ability (English) were mentioned as being (very or somewhat) important by more than 90% of those trainees responding. It was found that being a member of an accelerated rice improvement program was mentioned less frequently by IRRI Research trainees as being a very important factor in their selection (42.4%), than was the case with the CIMMYT

group (64.4%). Another interesting difference between these two trainee groups was the importance of seniority in the selection process. While 40.8% of the CIMMYT group indicated this factor was very important in their selection, only 15.2% of IRRI research trainees mentioned it as being very important. Since it would be expected that the type and level of bureaucratic procedures (seniority being a commonly used objective criteria for such purposes) would not differ significantly between different governmental research programs, it would appear that the application process for a substantial number of IRRI research trainees is initiated outside of regular organizational channels. Since rice research workers can apply directly to IRRI for a training fellowship (an unusual practice for CIMMYT), this may account for some of these differences. As was the case with the CIMMYT group, subjective criteria (personal relationships) were mentioned rather infrequently as being an important factor in the selection of former IRRI research trainees.

While other types of selection criteria such as personal qualities and intellectual ability may be identified through field interviews, these characteristics could not be measured and presented in a study of this type. It is possible, however, to present some other types of quantitative data which will help to give a descriptive profile of those research trainees that are being selected for training at IRRI.

IRRI Research Trainee Profile

The mean age of rice research trainees when entering the training program was 30.4 years. Of the 234 respondents in this study, there were 209 (89.3%) men and 25 (10.7%) women.

The educational prerequisites to enter one of IRRI's research training programs are quite explicit; and, judging from the educational backgrounds of the trainees, these degree requirements are closely adhered to with few exceptions. The following table indicates the number and percent of trainees at each educational level at the time of acceptance into the IRRI research training program:

TABLE VI-5

Highest Educational Level Attained by IRRI Research Trainees Prior to Entering the Training Program

Highest Educational Level Attained	N	%
Less than B.S. Degree	4	1.8%
B.S. Degree or Equivalent	142	62.3%
M.S. Degree or Equivalent	53	23.2%
Ph.D. Degree	29	12.7%
Total	228	100.0%
Number not Responding	6	

As mentioned in the second chapter, several authors have stated that agricultural personnel selected for academic training in the United States frequently have urban backgrounds or an urban orientation. These types of trainees are considered to be generally

unfamiliar with the agricultural problems of their countries; therefore, their research effectiveness is called into question. While the issue of the effect of urban/rural background on work performance will be considered later, the objective here will be to present different types of data which will help describe the types of backgrounds that are common to the IRRI research group. First, to determine how many grew up in rural areas, trainees were asked to describe the place where they lived most of the time until they were 12 years of age.

TABLE VI-6

Place Where IRRI Research Trainees Lived Until 12 Years of Age

Place	N	%
Rural	138	59.5%
Urban	94	40.5%
Totals	232	100.0%
Number not responding	2	

Next trainees were asked to give their father's occupation or profession to determine how many trainees came from farm families.

Finally respondents were asked to indicate if the source of their family's income, when they were growing up, was mainly from agricultural sources; and if so, to indicate the primary source of that income.

TABLE VI-7

Occupation of Fathers of IRRI Research Trainees

Occupation	N	%
Farmer or farm worker	71	31.4%
Agriculturalist (research or extension worker)	12	5.3%
University Educator	5	2.2%
Elementary or Secondary Teacher	21	9.3%
Professional (Medicine, Law, etc.)	20	8.8%
Government Civil Servant	40	17.7%
Industry or tradesman	14	6.2%
Businessman	32	14.2%
Other (e.g. military)	11	4.9%
Totals	226	100.0%
Number not responding	8	

TABLE VI-8

Main Source of Family Income When Trainee Was Growing Up

Main Source	N	%
Family owned & rented land	26	11.1%
Family owned & cultivated land	67	28.6%
Family rented or sharecropped land	5	2.1%
Family members worked as agricultural laborers	2	0.9%
Other sources of agr. income	1	0.4%
Total - Main source Agricultural	101	43.1%
Main source non-agricultural	133	56.9%
Grand Total	234	100.0%

While the proportion of research trainees with an agricultural background is not as high as some might hypothesize, approximately 60% of former trainees did grow up in rural areas with 43% of the respondents indicating that their families' income, while they were growing up, was mainly derived from agricultural sources. In addition, nearly 37% of all respondents indicated that their fathers were directly involved in agricultural production or were professional agriculturists. Since the proposition has been put forward by some authors that an agricultural background has a positive effect on the job performance of agricultural research workers, this relationship will be tested later in the study.

While IRRI indicates that all of its trainees must be recommended by his or her employing institution to be accepted as an IRRI trainee, it is interesting to note that 20 or 8.6% of the respondents were students prior to entering the training program, with another 2 respondents indicating that they were unemployed before coming to the training program. While it is possible that many, if not all, of the students were still associated with a national program, it must be pointed out that these particular trainees must have been absent from their work organizations for a considerable length of time and would likely function more or less as new employees upon their eventual return. The following table indicates the organizational affiliation of the other respondents.

As expected, the majority of IRRI's research trainees come from government research organizations. Even so, more than one-fourth of the respondents in this group worked for an agricultural

TABLE VI-9

Types of Organizations IRRI Research Trainees were Working for When Selected

Type of Organization	N	%
Government Research Organization	133	56.8%
Government Extension Organization	6	2.6%
Agricultural College or University	64	27.3%
Other (Government) Organization	9	3.9%
Not Working (student or unemployed)	22	9.4%
Totals	234	100.0%

college or university before coming to the training site.[2]

Of those IRRI research trainees who were working prior to coming to the training site, 104 participants (50.0%) indicated that they had been working only with rice, with another 76 trainees (36.5%) having worked with rice and other crops. Twenty-eight trainees (13.5%) said they had not worked with rice before coming to IRRI. Four respondents (in addition to the 22 trainees who were not working before entering the training program) failed to respond to this question.

Trainees were asked how many years they had been working for their current organization, before being selected for the training program. While one participant had worked more than 20 years before coming to the training program, the average number of

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[2]Note: The organizational affiliation of IRRI research trainees, as contrasted with the CIMMYT group is considerably different; 86% of CIMMYT trainees had worked for government research organizations while only 2.3% were associated with agricultural colleges or universities.

years on the job for the employed group was 5.8 years. Next trainees were asked to describe the main type of work that they were engaged in prior to coming to the training site.

TABLE VI-10

Main Type of Work Carried Out by IRRI Research Trainees Prior to Entering the Training Program

Main Type of Work	N	%
Mainly Administrative Work	5	2.5%
Mainly Field Research Work	110	55.0%
Mainly Laboratory/Greenhouse Research	43	21.5%
Mainly Field Extension	6	3.0%
Mainly Teaching	36	18.0%
Totals	200	100.0%
Combination of the above or other	10	
Number not responding	24	

These data reflect that more than three-fourths of IRRI research trainees were actively engaged in full time research before coming to the training site[3] with 18% working mainly in teaching positions. It should be noted that slightly more than half of the respondents who are employed by agricultural colleges and universities were apparently working in teaching rather than research positions prior to entering the training program.

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[3]Note: The percentage of CIMMYT trainees doing field research work is 83.5%, as contrasted with 55.0% for the IRRI research group.

To summarize, it appears that IRRI is generally accepting relatively young (30 years of age), but experienced (nearly 6 years on the job) research workers for its research training programs. The important points that contrast the CIMMYT and IRRI research groups are: (1) that IRRI accepts more than one-fourth of its trainees from agricultural colleges, (2) that more of the IRRI trainees are doing laboratory/greenhouse work (21.5% vs. 5.0%) and teaching (18% vs. none) prior to entering the training program and (3) that the educational level of IRRI trainees is somewhat higher than the CIMMYT group. Other independent characteristics between the two groups appear to be quite similar.

While many of the individual characteristics of research trainees being selected for the CIMMYT and IRRI research training programs are quite similar, the selection strategy and procedures followed by the two centers appear to be different. In particular, the strategy followed by IRRI in selecting trainees appears to be largely one of reacting to requests that come in from national programs or from individual candidates directly. While some senior scientists indicated that they have identified training candidates during visits to national programs, this was not the general rule. Instead the local IRRI representative and/or national program leader make candidate selections; or, the candidate takes the initiative on his own behalf. In these cases the department deals, on an ad hoc basis, with each application (on its own merits) as it is received. The point that appears important here is that the senior research scientists within IRRI generally do not work

hand in hand with their research counterparts in national programs to systematically up-grade the research skills of middle-level technical personnel in these programs. Rather the research departments rely on the administrative leadership of IRRI to coordinate and to facilitate the preliminary selection and screening process. Therefore in many cases, by the time the research department actually receives the application, most of the critical selection decisions may have already been made (i.e. who the candidate will be and what research problem area he will study).

Before moving on it should be made clear that the purpose in pointing out these differences in selection procedures is not to make value judgements, but to respond to the concerns expressed about selection procedures by one of the centers. Therefore, it seems essential to make as explicit as possible the strategies being followed by each.

The next section will deal with the research training programs themselves, focusing on the objectives, methodology and timing of each program. This descriptive material will be followed by a general evaluation of the rice research training programs by the respondents--from the perspective of their job situation after returning home.

Training

There are four different training categories with IRRI's research training program. These categories are degree and non-degree scholars, as well as post-M.S. degree and

post-doctoral fellows.

As mentioned in the introduction to this chapter, research scholars pursuing an M.S. degree at the University of Philippines College of Agriculture generally spend about one year taking course work at the college and another year conducting a research project that will serve as their Master's thesis. Non-degree scholars and post-M.S. degree fellows generally spend from six months to a year at the institute, while post-doctoral fellows frequently spend from one to two years at IRRI. The maximum length any research trainee in this survey spent at IRRI was 40 months, with the mean for the entire research group being 16.2 months.

Research trainees can work in one of 11 different disciplinary departments with IRRI. While there are considerable differences between these programs, in terms of disciplinary specialization, level of specialization and length of program, there are also many similarities--particularly in terms of training objectives and methodology employed. After a brief statement that will introduce the research training approach used at IRRI, the following two sections will be devoted to an examination of the training objectives and methodology that characterize IRRI's research training programs.

Research Training Approach

The training approach used by most departments at IRRI is centered around the research project. In particular, a non-degree research trainee "...reads in his field and plans, conducts and

reports upon a research program which he develops under the direction of a senior IRRI staff member. In many ways the program is similar to a graduate program in the Japanese or European pattern. Usually these courses of study require 1 year and they are rarely shorter than 6 months, about the time necessary to plan experiments and grow a rice crop" (McClung, 1972, p. 24).

While it is difficult to generalize exactly how each trainee is handled in each department, there are several characteristics that appear common to the project approach. One criterion that research projects must meet is that they be relevant to a particular production problem in the trainee's home country. In fact, as mentioned earlier, usually a pre-requisite for the trainee's acceptance into the research training program is that he has proposed a research problem area that is important back home. At the same time, however, these research projects must also be compatible with the department's and the senior scientist's own research program. While a more advanced and well directed research trainee may be given considerable independence in studying a particular problem, it appears to be a more common procedure for a trainee to work for a short time as a research assistant in his advisor's overall research program and then to select or be given a research project that represents one component of the scientist's overall research program. One point that is clear, "On a day-to-day basis, research training is fully integrated into IRRI's continuing research effort" (McClung, 1972, p. 22).

Training Objectives

While little is said in IRRI's publications about specific types of research training objectives, it is clear from the types of training offered and in talking to the senior research scientists that rather clear types of educational objectives are pursued. In attempting to make these objectives explicit, the procedure will again be to use the theoretical framework developed in Chapter II that categorize educational objectives into three general areas: (1) cognitive, (2) affective and (3) psychomotor or skill objectives. Since the cognitive domain is of primary importance to IRRI's research training approach, the discussion will begin there.

Cognitive Objectives

The cognitive area generally takes the research project approach by focusing on an "original" experiment(s) that the trainee plans, conducts and reports on himself--under the guidance of an IRRI scientist. In doing so, the trainee must first review the literature of previous research work in the problem area. To facilitate this preliminary work, IRRI maintains an excellent research library containing a comprehensive collection of the world's technical rice literature. In reviewing the relevant literature, the trainee's advisor will demand that he go beyond merely memorizing certain facts, theories, methodologies, etc. (recall of knowledge) that are important to his study. Rather the emphasis will be on understanding (comprehension) of the current body of knowledge and noting its relevance (application) to the specific problem that the trainee is

working on.

After becoming fully acquainted with previous research carried out in his problem area the trainee is expected to plan and conduct his own research project(s). The project is the main thrust of his technical training and in this segment of the training the primary educational objective is analysis. Furthermore, while all of these research projects are expected to focus on an important rice production problem, it is possible to further differentiate this educational objective as to the type of knowledge output that will result from the research effort.

In some cases, the analysis of a general production problem may point to the need for new information or knowledge about certain of the (genetic or production) factors involved before a possible solution can be identified. This type of problem necessitates the type of research effort that will (a) test existing knowledge under new conditions, or (b) test or screen new or existing materials, possibly under new or different conditions, to identify previously unknown characteristics about these materials (for example the screening of germ plasm to identify new sources of disease or insect resistance, or the testing of herbicides under different growth environments). This information in turn can be used in developing new genetic or production technology, which will need to be further tested and refined through field trials.

Another use of the research project may be to identify new factors and/or relationships that will help rice scientists to better understand the production problem being studied, which in turn may

suggest possible solutions to the problem. In this case the research project is used to test new hypotheses that are generated in the process of studying the problem. This type of research would also be contributing to the body of knowledge, but would be on a higher theoretical level than the first type of research. Even though this type of knowledge output is somewhat more theoretical, it might also be directly utilized in developing new genetic or production technology to alleviate the effect of a production problem.

Not all research trainees at IRRI carry out a research project as part of their training program. In particular, most non-degree trainees in varietal improvement learn the mechanics of operating a rice breeding program, rather than doing a research project in genetics. In these cases trainees work largely as research assistants in IRRI's on-going varietal improvement program, spending time actually performing all of the necessary tasks involved in operating such a program.

In this particular program the cognitive and psychomotor objectives are quite similar to those found in CIMMYT's Wheat Breeding Training Program (see pages 125-130). While there are some important differences in the actual operations (both in terms of structure and function) of the CIMMYT and IRRI breeding programs, their research objectives are more or less the same: to produce improved, high yielding germ plasm for use by national programs.

First trainees must learn the mechanics of running a rice breeding program. This involves understanding the research

methods (cognitive: knowledge/comprehension) used in the IRRI program as well as mastering the necessary research skills (cognitive/psychomotor objectives) involved in such a program--such as: planting breeding nurseries and yield trials, making crosses, scoring disease reactions, making plant selections, recording heading dates, evaluating grain quality, etc.

The second major type of educational objective involved in this type of training (also in the cognitive domain) concerns the process of creating new genetic combinations (synthesis) by bringing together desirable characteristics from different genetic sources; and then to use appropriate selection techniqies and criteria to evaluate the progeny of these combinations to identify and develop superior germ plasm and varieties.

Another research training program that does not use the project approach is the short term trainees in agricultural engineering. While there are only a few respondents that fit into this category, this is a different type of training that should be discussed briefly.

In this case IRRI has developed simple, low cost machinery that can be used by the small scale rice farmer. While these machines were initially built and tested under Philippine conditions, IRRI's objective is to make simple, labor saving technology available to all rice growing countries of Asia. To do this, machines must be tested, evaluated and demonstrated in other countries to determine if they are adaptable to the local rice growing conditions in these countries and, if so, to release models to local manufactures for local development and production. To carry out machinery

evaluations, IRRI brings a trainee to the institute for about two months to train him in these evaluation techniques. Again there are certain basic research methods and skills (cognitive/psychomotor objectives) involved in testing these machines; and, then, each type of machine must be evaluated against criteria established by IRRI's agricultural engineers. Generally this testing program is not overly complex and by having a trained evaluation specialist in different countries, IRRI can obtain reliable, preliminary feedback on its newly developed mechanical technology, before committing extensive amounts of staff time and travel to a particular project.

Affective Objectives

The attitudinal objectives emphasized by IRRI, while not being clearly articulated by either IRRI's publications or the senior staff, seem to reflect a "spirit of professionalism." One staff member expressed his concern that trainees take pride in their research work and he stressed that trainees "...must have their hearts in their research." IRRI's training brochure implies that training activities are designed to help the research trainee advance professionally, "...and, in so doing, contribute to research progress in his country" (IRRI, "The Training Program," p. 6). Another IRRI publication suggests that research trainees absorb a "... sleeves-up attitude toward research" (IRRI, "IRS & Beyond," p. 16). Finally through Saturday Seminars and day-to-day contacts, trainees see a spirit of professional cooperation among the senior staff. These types of cooperative efforts and interactions are stressed as essential to a productive research institution.

While the emphasis at IRRI is on training hard working, productive scientists, the project approach focusing on original research (as opposed to applied research) does not appear to cause any serious value conflicts or attitudinal problems among trainees. The research output in most cases is new knowledge which frequently results in a joint paper between the trainee and his advisor. These publications do help the trainee professionally and contribute to his professional standing in his research organization back home. Furthermore in some cases the trainee is able to do research that is not possible in his home country, because of the lack of necessary scientific equipment. Therefore the general thrust of attitudinal change is not to stress different types of research activities and different ways of organizing research (as was the case in the CIMMYT wheat training program), but to stress professional growth through hard work and cooperative interchange.

Cognitive/Psychomotor Objectives

All of IRRI's research training programs stress "learning by doing," therefore, trainees get first hand experience in carrying out the research skills appropriate for their own particular project or program. While in some cases research trainees come to IRRI for the expressed purpose of learning specific research methods and skills; in other cases skill training is largely instrumental to actually solving the research problem.

All trainees receive sound training in research methodology and (particularly the younger, less experienced trainees) emerge from

this experience with a full understanding as to how a research project should be planned and implemented. In doing so they acquire a specific set of research skills that may be used in future research work.

Training Methodology

Much of the discussion thus far has indirectly touched on the training methodology employed in this program. In fact, it was necessary to present the concept of the research project approach to training in order to clarify the educational objectives being sought by IRRI. Therefore, the following section will be used to present a few additional facts about the training program before moving on to the evaluation and analysis of this research training program.

IRRI research trainees generally specialize in one phase of rice research; therefore, they are assigned to work under the guidance of a senior scientist in one of the eleven disciplinary departments within IRRI's research program. The following table gives a breakdown as to the number of respondents that worked in each of these departments.

Since the research project is the primary training mechanism used by IRRI in this program, several questions were asked to determine how many trainees actually completed research projects and the number of projects completed per trainee.

As was pointed out earlier in this study, the publication of research papers is an excellent means for a scientist to gain professional recognition in his field. Since one expressed goal

TABLE VI-11

IRRI Research Respondents by Departmental Specialization

Department	N	%
Agronomy (cultural practices)	40	17.3%
Plant Breeding and Genetics	54	23.4%
Soil Chemistry	17	7.3%
Soil Microbiology	12	5.2%
Plant Pathology	21	9.1%
Entomology	19	8.2%
Plant Physiology	20	8.7%
Cereal Chemistry	11	4.8%
Agricultural Engineering	14	6.0%
Agricultural Economics	11	4.8%
Statistics	8	3.5%
Communications*	4	1.7%
Totals	231	100.0%
Number not responding	3	

*Communications is no longer a department within IRRI.

of IRRI is to help trainees advance professionally, respondents were asked if they had been able to publish (including being a joint author with their major advisor) any research papers based on their research work at IRRI. Table VI-13 indicates the results achieved. Of the respondents that did conduct research projects as part of their training, about 60% were able to publish a research paper(s) based on their work at IRRI, with a total of 187 published

TABLE VI-12

Research Projects Completed by Research Trainees While at IRRI

Number of Projects Completed	N	%
None (Varietal Improvement & Short Term Agricultural Engineering Trainees)	48	22.3%
One project	96	44.6%
Two projects	41	19.1%
Three projects	18	8.4%
Four or five projects	12	5.6%
Totals	215	100.0%
Number not ascertained	19	

TABLE VI-13

Number of Research Papers Published by IRRI Research Trainees Based on Research Work Carried Out at IRRI

Number of Papers Published	N	%
None Published	69	39.4%
One Paper Published	61	34.9%
Two Papers Published	23	13.1%
Three Papers Published	14	8.0%
Four or More Papers Published	8	4.6%
Total	175	100.0%
Number not specified	6	
Not applicable or not responding	53	

research papers being reported. Given the nature of the research training program and with about one-fifth of research trainees spending 6 months or less at IRRI and nearly one-third more working on M.S. degrees at the College of Agriculture (therefore actually spending no more than one year in actual research at IRRI), the research productivity of these trainees--in terms of their publication record--appears to be very good.

To summarize, the training approach used in the IRRI research training program appears to provide research workers with a solid research experience, working under the guidance of an experienced research scientist. The primary objective of the "research project" approach is to train potential young scientists how to analyze a problem and how to use research as a tool in finding answers to that problem. In most cases the methodology of training is for trainees to plan, conduct and report on original research experiments, which generate new knowledge about certain production problems. This information in turn may be used (by themselves or other research workers) in developing new genetic and/or production technology. At IRRI these technology development functions are primarily left to the varietal improvement and rice production research programs.

In varietal improvement the training approach used (for non-project research trainees) is to have these participants function as research assistants in the on-going IRRI rice breeding program. In doing so these trainees learn first hand each step involved in developing new, improved varieties. The rice

production program focuses on the extensive use of different types of applied research trials. The training approach used in this latter program will be discussed in detail in Chapter VII.

Trainee Feedback on the Training Program

IRRI is working with research workers who come from many different countries, representing different types of rice research problems and diverse types of organizational approaches for the study of these problems. By using a research project approach to training, IRRI can tailor each trainee's program to focus on some aspect of a relevant production problem back home. The next section will give an assessment as to how each trainee views various aspects of this training approach.

Adequacy of Pre-Arrival Information

Trainees were asked to assess the adequacy of their information about the training program before coming to the training site. Of the 228 trainees who responded to this question, 55 (24.1%) indicated that the information was very adequate; 107 (46.9%) said it was somewhat adequate; 54 (23.7%) said it was somewhat inadequate; while 12 (5.7%) respondents said it was very inadequate. With nearly 30% of the respondents indicating that their pre-arrival information was inadequate to some degree, this would suggest that IRRI should examine its current procedures of informing candidates about the training program. To determine which types of information are currently being received by trainees,

respondents were asked to check the types of materials and information they received before their departure.

TABLE VI-14

Types of Information Received by IRRI Research Trainees Before Coming to the Training Site: N=234

Types of Information Received	N	%
Specific Objectives of the technical training program	131	56.0%
Outline of the proposed plan for the technical training	91	38.9%
IRRI Administrative policies and regulations for trainees	90	38.5%
Relationship between the objectives of the technical training program and the national rice research program	94	40.2%
Information about the Philippines (N = 180)	44	24.4%
Trainees not receiving any information	20	8.6%

It would appear that most trainees are getting general information about the training program before their arrival, but information on specific aspects of the technical training appear to be lacking in many cases. While providing the trainee with information about the Philippines may not be a critical part of the pre-arrival information needed, it is likely that the Philippines Tourist Agency can provide some materials to acquaint the candidate with his new host country.

From the information shown in the preceding table, a scale was developed to quantitatively measure the total amount of

information received by each trainee and to differentiate among trainees as to the amount of information received. The mean of this scale for the IRRI research trainees was 1.9 types of information received. This pre-arrival information scale will be used later in the study to determine if the amount of information received by the trainee had any effect on the use of training after the participant returned home. It was expected that in later years, after the program became better organized, that trainees would receive more complete pre-arrival information, but an analysis of the data showed that there was little difference between years in terms of the amount of information received by trainees.

Finally trainees were asked to indicate the best source of information about the training program before their departure. Nearly 40% of the respondents indicated that an IRRI official was their best source of information, with about one-fourth indicating their supervisor as being their best source. Only 14% indicated that a former trainee was their best source and the remaining respondents listed a variety of other sources of information. While it was not determined when candidates get their information from "an IRRI official," it appears likely that during the selection interview the potential trainee actually learns the most about the training program.

Trainees' Reaction to the Actual Training Program

First trainees were asked to indicate how they found the level of the training program, considering their previous background

and experience. Since each trainee's program is tailored to meet the specific needs and interests of the participant, it was expected that most trainees would find the level of training to be "about right" for them.

TABLE VI-15

IRRI Research Trainees' Assessment of the Level of Training by Educational Level When Entering the Program: N=234

Previous Educational Level	Level of the Training Was: Too Elementary	About Right	Too Difficult	Total
B.S. Degree	12	121	12	145
M.S. Degree	7	43	2	52
Ph.D. Degree	5	24	0	29
Total	24	188	14	226
Number not responding	8; X^2 = 3.18 with 4 df (P=.5287, N.S.)[4]			

Approximately 10% of IRRI research trainees found their work too elementary, while 6% said it was too difficult. While the Ph.D. and M.S. degree trainee groups had a higher proportion of respondents indicating the training was too elementary, this trend was not statistically significant. It is concluded, therefore, that IRRI is providing research training at a level appropriate for most participant's previous background and experience.

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[4]For a definition of the statistical notations used this X^2 test of significance, see footnote 5 on page .

Next trainees were asked if the technical skills and research techniques they learned at IRRI were appropriate for the jobs to which they expected to return.

TABLE VI-16

Appropriateness of Technical Skill Training for IRRI Research Trainees

Technical Skills Were	N	%
Very Appropriate	140	61.7%
Somewhat Appropriate	81	35.7%
Inappropriate	6	2.6%
Totals	227	100.0%
Number not responding	7	

It appears from the trainees' assessment that the technical skills and research techniques taught during the training program were generally quite appropriate for the job to which they expected to return.

Then trainees were asked to assess the amount of supervision and direction given by the senior staff during their training. Looking at the departments as a whole, the general reaction of the trainees was relatively good with 129 trainees (55.8%) indicating that staff support was very adequate; 68 trainees (29.4%) saying it was somewhat adequate; 27 trainees (11.7%) indicating it was somewhat inadequate; and 7 respondents saying it was very inadequate. Three trainees failed to respond to this question. Next, trainees' assessment of staff support and direction is

categorized by departments.

TABLE VI-17

Adequacy of Senior Staff Supervision and Direction, As Assessed by IRRI Research Trainees, by Department

Department	Staff Supervision & Direction Was: Very Adequate	Somewhat Adequate	Inadequate*	Total: %	N
Agronomy	47.5%	27.5%	25.0%	100.0%	40
Plant Breeding & Genetics	53.7%	27.8%	18.5%	100.0%	54
Soil Chemistry	35.3%	52.9%	11.8%	100.0%	17
Soil Microbiology	58.3%	--	41.7%	100.0%	12
Plant Pathology	61.9%	28.6%	9.5%	100.0%	21
Entomology	63.2%	31.6%	5.2%	100.0%	19
Plant Physiology	70.0%	25.0%	5.0%	100.0%	20
Cereal Chemistry	60.0%	40.0%	--	100.0%	10
Agricultural Engineering	53.8%	46.2%	--	100.0%	13
Agricultural Economics	54.5%	27.3%	18.2%	100.0%	11
Statistics	62.5%	37.5%	--	100.0%	8
Totals: Percent	55.1%	30.2%	14.7%	100.0%	
Number	124	68	33		225
Number not responding:					9

*Note: the inadequate category is made up of "somewhat inadequate" and "very inadequate" responses; the number of responses in the very inadequate category was small.

Trainees were asked with which aspect of the training experience at IRRI they felt most satisfied. The following factors were among those mentioned most frequently.

TABLE VI-18

Aspect of IRRI Training With Which IRRI Research Trainees Were Most Satisfied

Aspect Most Satisfied With	N	%
Research Methods, Skills and Techniques Learned	43	22.6%
Seminars	35	18.4%
Availability of Excellent Facilities, Equipment and Library	34	17.9%
Doing Individual Research Projects	22	11.6%
Good Relations with Senior Staff	22	11.6%
Practical Field Training	21	11.1%
Other	13	6.8%
Total	190	100.0%
Number not responding	44	

Then trainees were asked to indicate which aspect of the training experience at IRRI they were least satisfied with. Again those factors mentioned most frequently are presented.

While certain trainees had some rather specific problems or complaints to make about their training experience, nearly half of the respondent group reacted to this question with a positive response. In addition, another 81 trainees or 1/3 of the total number of respondents failed to respond to this question,

TABLE VI-19

Aspect of IRRI Training with Which Research Trainees were Least Satisfied

Aspect Least Satisfied With	N	%
Technical Training: Lack of sufficient time spent on particular technical area; inadequate instruction in a particular area or by a particular staff member	22	14.4%
Poor Relations with Senior Staff: Trainees felt they were doing the work and staff members were claiming the credit; personality conflicts; lack of time given by staff members	20	13.1%
Inadequate Administrative Support: unsuitable living environment/food; inadequate stipend/allowances	17	11.1%
Other	24	15.7%
Trainee Expressed his general satisfaction with the training program	70	45.7%
Totals	153	100.0%
Number not responding	81	

therefore, it is unlikely that these individuals had any strong dislikes to register about their training experience. It should be pointed out, however, that at the end of the questionnaire when trainees were asked to recommend ways IRRI might improve its training program, a large number of insightful comments were made. Therefore, while trainees appear to be generally satisfied with their training, they still have a number of useful ideas as to how the program can be improved.

Trainees' Overall Evaluation of the Training Program

In this section trainees were asked to evaluate the IRRI research training programs from several different perspectives. These responses serve to summarize how trainees presently assess their previous training experience at IRRI.

First trainees were asked to assess the technical training considering their previous training and experience. One hundred-forty trainees (60.1%) indicated the technical training was very appropriate, with another 84 respondents (36.1%) assessing it as somewhat appropriate. Six respondents (2.6%) were undecided, with only 3 trainees (1.3%) indicating that the technical training was somewhat inappropriate for their previous training and experience.

Next respondents were asked to assess the technical training considering their home country condition.

TABLE VI-20

Appropriateness of Technical Training Considering the Home Country Conditions of IRRI Research Trainees

Level of Appropriateness	N	%
Very Appropriate	126	54.3%
Somewhat Appropriate	87	37.5%
Undecided	11	4.7%
Somewhat Inappropriate	8	3.5%
Very Inappropriate	0	--
Totals	232	100.0%
Number not responding	2	

Trainees were then asked to indicate how helpful the technical training at IRRI had been in furthering their own personal career plans. One hundred-twenty-five respondents (53.4%) considered the IRRI training as being very helpful to them, while another 71 trainees (30.5%) rated the training experience as being somewhat helpful. Nineteen trainees (8.1%) said the experience had made little difference in furthering their plans, while 3 respondents (1.3%) felt the training had been detrimental to their careers.

Trainees were also asked to assess the administrative support (for example: living accommodations, allowances, transportation and other services) they received during all phases of their training program. Here the responses were somewhat less favorable with 102 trainees (43.8%) being very satisfied; 71 respondents (30.5%) being somewhat satisfied; 24 trainees (10.3%) taking a neutral position; but with 36 trainees (15.4%) expressing dissatisfaction in this category. While it is impossible to say exactly why there is more dissatisfaction regarding administrative support, it was the investigator's observation--after spending three weeks eating and living with the current trainees--that the paternalistic attitude held by some staff members in the supporting service may be responsible for many of these negative responses. One particular issue that came up rather frequently was the rather restrictive and puritanical social norms forced on dormitory residents--many of whom are mature, experienced research workers. While some of these rules may be appropriate for undergraduate students, they do not appear warranted for this clientele group.

Finally trainees were asked to give their overall assessment of their total training experience at IRRI.

TABLE VI-21

IRRI Research Trainees' Level of Satisfaction with the Overall Training Program

Level of Satisfaction	N	%
Very Satisfied	130	55.5%
Somewhat Satisfied	83	35.5%
Neutral	18	7.7%
Somewhat Dissatisfied	3	1.3%
Very Dissatisfied	0	--
Total	234	100.0%
Number not responding	0	

Finally trainees were asked to assess the extent to which the training experience at IRRI had made a difference in their ability to help solve the agricultural problems of their country.

TABLE VI-22

Extent to Which the IRRI Research Training Made a Difference in the Trainees' Ability to Help Solve Agricultural Problems

Change in Ability (Self-assessed)	N	%
Little or no difference	48	21.0%
Some difference	99	43.2%
Important difference	82	35.8%
Total	229	100.0%
Number not responding	5	

Then those trainees that felt the training had made some or an important difference in their ability were asked to explain why they felt this way. The reason most frequently mentioned was that the training had "increased their technical skills, knowledge and ability" (43 respondents). The next reason most frequently mentioned was "the increased confidence to do the job" (19 respondents), followed by "the training gave me a better perspective in knowing what jobs to undertake" (18 respondents). Other reasons mentioned less frequently were: "I am doing a needed job that hadn't been done before"; "the training has provided needed practical experience"; "the training had made me more production oriented," etc.

From talking with research trainees at IRRI and with former trainees in the field and in viewing the survey data, the investigator must conclude that, for most trainees, the IRRI research training program is probably one of the best educational or training experience that respondents have participated in. Even so, the investigator sensed a feeling among some trainees that the training program was not completely meeting the work needs of their job assignments. Therefore one question was asked in an attempt to assess how many trainees felt that the current approach was not altogether adequate for their research assignments back home. It should be noted that in the preceding question, the in-service training approach was related to the rice production training program; therefore, most respondents had some frame of reference to an alternative training approach. While this question is recognized as an inadequate attempt to appraise IRRI's current research

TABLE VI-23

IRRI Research Trainees' Reaction to the Present Training Approach

Trainee suggests that the research training program should be	N	%
Continued as present	106	50.2%
Continue as present, but add more rice production training	61	28.9%
Changed to be an "in-service" training program for research workers	44	20.9
Totals	211	100.0%
Number not responding	23	

training approach--in that respondents are only familiar with the training approach they have experienced directly--the fact that 50% of the respondent group is suggesting a more production or practical oriented training approach is an important finding.

In an attempt to better understand this response, a number of cross tabulations with different independent variables were prepared. The results of these analyses showed no apparent relationship between trainees who desired or did not desire a different training approach, and (1) the department in which the training was received, (2) the use of training after returning home, or (3) whether or not the research worker was able to continue working on his research project after returning home. In the case of 4 other variables, however, there were some observations or trends that should be noted. These findings were: (1) trainees authoring 2 or more research papers, based on their

research at IRRI, clearly favored the individual research project approach; (2) respondents conducting laboratory or greenhouse research tended to favor the project approach more frequently (68.2%) than field research workers (43.9%); and (3) post-doctoral research fellows tended to prefer the project approach more frequently (64.0%) than M.S. degree fellows (50.0%) or research scholars with B.S. degrees (46.3%).

The fourth variable deals with the level of the respondent's present position in his work organization; and, since these results provide an important perspective on IRRI's research training approach, they are presented in tabular form.

TABLE VI-24

IRRI Research Trainee's Preference Regarding Training Approach by Level of Present Job Position in Work Organization

Job Level of Trainee's Present Position in work Organization	Continue as Present	More Rice Production	Change to In-Service Approach	Totals N	Totals %
Policy Level	1	2	7	10	5.2%
Senior Level	44	22	21	87	45.3%
Middle Level	43	30	14	87	45.3%
Lower Level	4	4	0	8	4.2%
Totals: N	92	58	42	192	
%	47.9%	30.2%	21.9%		100.0%

Number not responding (including current students, etc.): 42

$X^2 = 14.46$ with 6 df (P = .0249 *)

These data suggest that respondents with high level positions in their work organization are more likely to recommend more production oriented, in-service training approaches than participants holding lower level positions (statistically significant at the .05 level). Those in lower level positions are more likely to recommend a research project approach. Most interesting was the fact that 7 out of 10 former trainees who now hold policy level positions in their national programs recommended changing the present project approach to an in-service training approach, similar to the one used in the rice production training program, with only one policy maker supporting the present approach. If the assumption can be made that these research leaders understand both the research problems that need to be solved in their own countries and also have an understanding as to how this research work should be undertaken, this observation raises serious questions regarding the current approach used in training rice research workers.

In summary, it appears that IRRI research trainees have evaluated their previous training experience in rather positive terms--from several different perspectives. In particular, over 90% of the respondents assessed the subject matter content of their training as being more or less appropriate for their previous background and training, and for their home country conditions. This finding would indicate that IRRI's policy of not selecting a research trainee unless he proposes working on a research problem relevant to his background and the needs of his country is, in fact, working very well.

In terms of the training approach used by IRRI, however, it would appear that the individual research project approach may not be the most effective means of preparing some research workers for their job assignments back home. One IRRI scientist commented on the problem of preparing trainees for jobs in their own countries. He indicated that IRRI had gone with the project approach since scientists were frequently unfamiliar with trainee work assignments and situations in their home country and this approach offered the most flexibility and trainees could work in more diverse jobs. What appears to emerge from the data, which would give support to the investigator's initial observations in the field, is that while the research project approach gives trainees a solid research experience in analyzing a particular research problem and in developing appropriate answers or solutions to this problem, this approach may not be appropriate for the research assignments some trainees face after returning home. Later in this chapter, when actual on-the-job research behavior and research output is considered, this issue will be examined in more detail.

Post-Training: The Types and Level of IRRI Contact with Former Research Trainees

As mentioned earlier, the training institution can do much to help the trainee translate his new skills and knowledge into new behavioral patterns once back home on the job. This support may be as little as just letting the trainee know that IRRI is still interested in what he is doing and hasn't forgotten him, to a fully developed

cooperative program that involves a locally assigned IRRI representative or research team--with material and financial support. The purpose of this section is to give a general picture as to the types and amounts of follow-up contact individual research trainees have had from IRRI since returning home.

Correspondence

Trainees were asked if they have written to and have received letters from IRRI scientists and officials since returning home. Sixty percent of former research trainees indicated that they had written to IRRI staff members since returning home, and the average number of letters written per trainee for this corresponding group was 8.4 letters. Approximately 59% of the respondents indicated that they had received letters from IRRI scientists and officials, with a mean of 7.24 letters being received by each trainee in the corresponding group.

Visits

Next trainees were asked if they have been visited by an IRRI scientist or official since returning home. Out of the 215 trainees who responded to this question 62 or 28.8% indicated they had never been visited since returning home. Among the 153 trainees who had been visited, the mean number of visits per trainee was 2.9 visits.

One-hundred and sixty-one trainees indicated they worked in national programs where an IRRI representative or team of scientists was assigned. This group of respondents was asked to indicate the

number of times during the past year (1972) they had been visited by a local IRRI representative or scientist. Ninety-five trainees or 59% of this group said they had never been visited during the past year. For those trainees that had been visited, the mean number of visits per trainee was 3.8 visits. In certain cases this last figure is biased downward since some trainees work side by side or in daily contact with a locally assigned IRRI staff member.

IRRI Publications

One of the easiest communications mechanisms by which IRRI can inform former research trainees of new developments in rice research is through IRRI's publications. These publications consist of newsletters, annual reports and technical papers, booklets and books. The number of former participants receiving information and support through this mechanism, however, has been very low, with only 83 respondents (35.5%) indicating that they have been receiving publications. Of the other 151 trainees, 96 or 41% said they were not on IRRI's mailing list, with another 55 trainees (23.5%) being unsure whether or not they are still receiving publications from IRRI. This finding has rather serious implications for certain assumptions held by IRRI scientists.

To reiterate, one primary output of IRRI's research activities is new knowledge about solving rice production problems in the tropics. These findings are primarily communicated through IRRI's reports and technical publications. In talking with senior scientists, there was a commonly held belief that former research trainees

were kept abreast of recent developments in rice research through IRRI's publications. In fact, however, only slightly over one-third of this group were still receiving these materials on a regular basis. It should be noted that all respondents to this survey completed a separate form so that they would be included on IRRI's mailing list. Unless they were no longer interested, all respondents should now be receiving these materials.

International Cooperative Trials and Nurseries

Trainees were asked if their national rice research programs had received any international cooperative trials or nurseries during the past two years. Ninety-six respondents (45.1%) indicated that such trials or nurseries had been received at their local experiment stations. Fifty-three trainees (24.9%) indicated that their experiment station had not received such materials in the last two years, with 64 trainees (30.1%) being unsure whether such trials or nurseries had been received. Twenty-one trainees failed to respond to this question.

Post-Training Research Workshops

While IRRI holds international symposia from time to time and has annual international rice research meetings, these activities usually involve high level research scientists, rather than former research trainees. Only 44 trainees (18.8%) indicated that they have attended any of these meetings or conferences; and, in certain cases, attendance was noted as being at the end of their training

program, prior to returning home. In the case of international meetings, as a follow-up support mechanism, it would appear that trainees are generally invited to attend such meetings because they have risen to leadership positions in their national rice research programs, rather than because of their status as former trainees.

Use of Training

The purpose of this section will be to examine several different dependent variables to determine how well research trainees have been able to use the training received at IRRI since returning home.

The Trainees' Self Assessment

Those trainees who had conducted individual research projects during their training at IRRI were asked if they had been able to continue working and building on these projects after returning home.

TABLE VI-25

Number of IRRI Research Trainees Allowed to Continue and to Build Upon Research Projects Started at IRRI

Research Projects Started at IRRI	N	%
Trainee was able to continue work on research project after returning home	114	63.7%
Trainee was not able to continue work on research project after returning home	65	36.3%
Totals	179	100.0%
Not Appropriate or not ascertained	55	

Nearly two-thirds of IRRI's research trainees have been able to continue working on the research projects that they initiated or carried on while at IRRI. Since the research project can be viewed as much as a training tool, as an end in itself, this level of carry over into the actual job assignment appears to be relatively high.

Trainees were asked to assess how much of the training they were able to use during their first year on the job after returning to their home country.

TABLE VI-26

Use of Training by IRRI Research Trainees During the First Year on the Job

Level of Use	N	%
Little or no use	24	10.4%
Some Use	107	46.3%
Full Use	100	43.3%
Totals	231	100.0%
Number not responding	3	

Later trainees were asked to assess the extent to which they are using the training in their present job. The purpose was to determine if the training became less relevant and useful to the trainees' job assignment as time passed.

IRRI research trainees assess their overall use of training in relatively positive terms; and while the total number of trainees making full use of their training has decreased somewhat over time, there has also been a decrease in the number of trainees making

TABLE VI-27

Use of Training by IRRI Research Trainees in Their Present Job Assignment

Level of Use	N	%
Little or no use	11	5.1%
Some Use	120	55.8%
Full Use	85	39.5%
Totals	216	100.0%
Number not responding	18	

little or no use of training in their present job assignments.

In terms of the stability of training use, however, there has been considerable movement of trainees between use categories over time. For example among the 24 trainees making little or no use of training in year one, it was found that 18 had moved into higher use categories in their present job assignments. Likewise 20 trainees who had made some use of their training in year one, had moved into job assignments at the present time where they can make full use of their training; 5 trainees slipped into the little or no use category. Finally of the 100 trainees who had made full use of their training during year one, 31 had decreased their level of use in their present jobs. Therefore, while the overall assessed use of training remains fairly high, there appears to have been considerable instability among trainee research assignments which has resulted in differing levels of use of training over time.

Trainee Job Assignments as an Indicator of Level of Training Use

In considering the trainees' self assessment of their use of training, it is impossible to differentiate between direct and indirect use of training. In the case of the CIMMYT wheat training program, job assignment was important to the direct use of training, since the training approach was considered to be job specific. In the case of the IRRI research training program, however, this same assumption cannot be made. For example, university teaching personnel are selected for research training with the apparent objective of strengthening national educational programs. Providing teaching personnel with a solid research experience would have to be considered as a planned, but indirect use of training. Since IRRI is pursuing a more broad based institution building strategy, including both national educational and research institutions, both the direct and indirect uses of training must be considered as valid training objectives. Thus in this section, data will be presented on trainee job assignments, but the interpretation of this data will not be as directly concerned with the potential for the direct use of training as was the case in evaluating the CIMMYT wheat training program.

Job Assignment Following the Training Program

Trainees were asked if they had returned to the job that they had expected before their departure. This information was tabulated with a second variable that indicated if this was the same type of job

assignment the trainee had performed before coming to the training program. The objective being to determine if trainees returned to the jobs they had expected and if those jobs were the same or different jobs than they had performed prior to the training program.

TABLE VI-28

Job Returned to by Type of Job for IRRI Research Trainees

Job Returned To	Same Job	Somewhat Different Job	Very Different Job	Totals N	Totals %
Trainee returned to the job he had expected	138	35	3	176	86.3%
Trainee did not return to the job he had expected	5	14	9	28	13.7%
Totals: N	143	49	12	204	
%	70.1%	24.0%	5.9%		100.0%
Trainee was not working prior to entering the training program or didn't have a job after returning home				30	

These data show that, of those trainees who were working prior to entering the training program, 86% returned to the jobs they had expected, with over two-thirds of this respondent group returning to their former job assignments. These data parallel very closely the results found for the CIMMYT wheat group, except for the 30 participants who were not working prior to entering the training program.[5]

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[5]Note: all CIMMYT trainees were working prior to entering the training program.

While some IRRI staff members implied that they preferred the research project approach to training because it wasn't as job specific and thus more flexible for the trainee, these data suggest that the vast majority do return to expected jobs--with nearly two-thirds continuing to work on the research projects they started at IRRI. Therefore, the decision to use the research project approach to training should not be based on the expectation of job uncertainty, but on the merits of the approach itself.[6]

Present Job Assignment

Trainees were asked to give the descriptive title of their present job assignment, to determine how many are still working in the subject matter area for which they were trained and to determine how many are working in rice research programs.

Former trainees were then asked to name the principal crops they work with in their present job assignment. Eighty-eight respondents (40.7%) indicated that they worked only with rice, while

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[6]In fact, in the case of both CIMMYT and IRRI, it would appear that the training approach used is largely dependent on the type of research being carried on by the center and/or the specific department. For example, the varietal improvement department at IRRI is basically concerned with developing new genetic technology. To do this, plant breeders set up an on-going rice breeding program that will produce improved varieties of rice; they do not concentrate on research projects that will generate new knowledge about rice varieties. Therefore trainees assigned to this program do not follow a research project approach to training, but work largely as research assistants in the on-going breeding program, in much the same manner as wheat trainees are trained in CIMMYT's on-going wheat improvement program. On the other hand, the agronomy department by and large conducts research (projects) aimed at generating new knowledge about cultural practices for rice grown in the tropics. Therefore, trainees working in this department follow a research project approach to training.

TABLE VI-29

Present Job Assignments of Former IRRI Research Trainees

Job Category	N	%
Rice Breeder	39	16.7%
Rice Agronomist	27	11.5%
Plant Pathologist	14	6.0%
Plant Physiologist	5	2.1%
Entomologist	16	6.8%
Soil Scientist	19	8.1%
Cereal Technologist/Biochemist	7	3.0%
Agricultural Engineer	8	3.4%
Agricultural Economist	7	3.0%
Statistician	4	1.7%
Subtotal	146	62.3%
University Professor, teacher or training specialist	21	9.0%
Plant Breeder/Agronomist (Other crops)	8	3.4%
Agricultural Research Technician (non-specific)	10	4.3%
Experiment Station Manager	9	3.8%
Administrative Position in Agriculture	8	3.4%
Rice Extension Specialist	2	0.9%
Other (Business, farmer, teacher, etc.)	10	4.3%
Unemployed	2	0.9%
Graduate Student	18	7.7%
Totals	234	100.0%

another 68 respondents (31.5%) worked with both rice and another crop. Twenty-eight trainees (13.0%) said they do not work with any crops in their present jobs, while another 10 respondents (4.6%) said they only work with other crops. Twenty-two respondents (10.2%) failed to respond to this and several other questions dealing with rice research and/or production work, therefore it is unlikely that former trainees in this group are involved with rice research at the present time. The 18 graduate students could not respond to this question; but,it is likely that many of these individuals will return to rice research programs in their home countries after completing their degree programs.

Other Information on Present Job Assignments

In addition to determining how many former trainees are working in rice research and production programs at the present time and what their descriptive job titles are, trainees were also asked a number of questions to elicit more information about their current job assignments. First trainees were asked to indicate the type of work organization they are presently working for.

Then trainees were asked to describe the main type of work involved in their present position.

Next trainees were asked to describe the level of their current position within their work organization. The purpose of this question was to determine if former IRRI research trainees are moving into leadership positions in their work organization.

TABLE VI-30

Organizations Where IRRI Research Trainees are Presently Employed

Type of Organization	N	%
Government Research Organization	123	56.9%
Government Extension Service	4	1.8%
Agricultural College or University	59	27.3%
Company, Business or Industry	12	5.6%
International Organization	9	4.2%
Other	9	4.2%
Totals	216	100.0%
Not Applicable (graduate students)	18	

TABLE VI-31

Main Type of Work IRRI Research Trainees Are Presently Engaged In

Type of Work	N	%
Mainly Administrative	24	11.1%
Mainly Field Research	89	41.2%
Mainly Laboratory/Greenhouse Research	48	22.2%
Mainly Field Extension	6	2.8%
Mainly Teaching or Training	32	14.8%
Some Combination of the above, or other	17	7.9%
Totals	216	100.0%
Not applicable (graduate students)	18	

TABLE VI-32

Level of IRRI Research Trainee's Present Job Within the Work Organization

Level of the Job	N	%
Policy Level	10	4.7%
Senior Level	98	46.5%
Middle Level	95	45.0%
Lower Level	8	3.8%
Totals	211	100.0%
Not applicable or not responding	23	

Respondents were asked one final question to determine how stable their job assignments have been since returning home. In particular, trainees were asked if they were still working for the same organization that they were with prior to entering the training program.

TABLE VI-33

Job Stability of IRRI Research Trainees Since Returning Home

Trainee Is Working For	N	%
The Same Organization That He Was With Prior to Entering Training	145	67.1%
A Different Organization Than He Was Employed By Prior to the Training	52	24.1%
Trainee Was Not Working Prior To Entering the Training Program	19	8.8%
Totals	216	100.0%
Not Applicable (graduate students)	18	

To summarize the information presented about the job assignments of former IRRI trainees, it was found that 86% of respondents did return (the first year) to jobs they had expected before joining the training program. Another finding was that about 62% of former research trainees are working in job assignments that can be identified with the subject matter areas in which they were trained. In addition, approximately 72% of IRRI research trainees are currently working in, or are associated with, some type of rice research and/or production program. Of all respondents who are currently working, about 63% are mainly engaged in research work, with about two-thirds conducting field research and the other one-third doing laboratory or greenhouse research work. As was the case with the CIMMYT wheat group, IRRI research trainees are moving into senior level and leadership positions in their work organizations; but there appears to be less job stability or continuity among the IRRI research group since returning home, than was found among the CIMMYT group.[7]

Assessing Job Performance

Since the primary concern of this research is with building strong national research and production programs and the effect of training on the work behavior of former participants, the next section will examine the types of rice research, development and extension activities that former participants carried out during

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[7]Only 12.7% of CIMMYT trainees have changed organizations since returning home and all respondents were working prior to entering the training program.

the last year (1972).[8]

Present Research, Development and Extension Activities

Trainees were asked to indicate how many research experiments, applied research trials and production plots they had worked on and helped complete during the last main rice growing season in their country. Of the 234 respondents, 80 indicated that during the past year, they either had not worked in a rice research and/or production program, were a graduate student, or were in some type of work where they did not engage in these types of activities. For the remaining 154 participants who had worked in a rice research and/or production program, the actual number of experiments, replicated field trials and production plots were averaged for this sub-group to give the mean number completed per trainee.

Approximately 66% of former IRRI research trainees reported that they were actively engaged in the types of activities they had been trained to carry out. An examination of the preceding table gives a direct quantitative measure of the average work performance for each of these 154 respondents. In addition, it is possible to determine what types of research or production activities are being emphasized by former IRRI research trainees. While all types of research, development and extension activities,[9] are being

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[8]For a background statement which helps explain why the following assessment system was developed and used, please see page 158

[9]As defined by the functional model, which was developed in the first chapter on page 15

TABLE VI-34

Mean Level of Research and Production Activities Completed By Those IRRI Research Trainees who were Active in Rice Research and Production Programs During 1972

Type of Activity	Number & Percent of Trainees Conducting each activity (N = 154) N	%	Mean Level per Trainee (N = 154)
A. Laboratory or Greenhouse Experiments	65	42.2%	1.61
B. On Station Field Experiments	85	55.2%	3.48
C. Genetic Crosses	46	29.9%	19.9
D. On Station Replicated Applied Research Trials	57	37.0%	1.55
E. On Farm Replicated Applied Research Trials	38	24.7%	1.17
F. On Farm High Yielding Production Plots	39	25.3%	1.46

carried out by former participants, there appears to be more time and emphasis placed on knowledge generating types of research activities (types A & B), than on technology development (types C, D and E) or extension (type F).[10] This finding is logically consistent with the type of training IRRI research trainees receive, given the research project approach to training that IRRI currently employs in most of its research training programs.

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[10]This conclusion is partially based on the assumption that individual research experiments take more time to plan and execute than applied research trials. Themethodology of applied research trials can frequently be standardized and routinized to minimize time spent on planning and experimental design.

Level and Types of Contact with Agricultural Producers

It is assumed that IRRI is training research and production workers to help solve the problems of agricultural producers. To do this, research workers need feedback about farmer production problems (either through direct contact, or indirectly through extension workers). IRRI research trainees were asked several questions to determine their level of direct contact with agricultural producers.

One hundred and thirty-six of the respondents (approximately 63% of the former trainees presently working in their home country) indicated that they had direct contact with farmers during the past year. Of this group, 76 trainees (56.3%) indicated that the majority of their contact had occurred on farms. Another 32 respondents (23.7%) indicated that their contact had been with farmers coming to the experiment station. The remaining 27 respondents indicated that their contact had mainly occurred at their office (7.4%), at meetings (4.4%), or at some combination of the above locations (8.2%).

Next trainees were asked to indicate the type of contact they had had with farmers.

To summarize, it was found that about 63% of former IRRI research trainees are having some type of direct contact with farmers. The frequency of contact for most respondents was "several times per season" and the contact primarily occurred on farmers' farms and at the experiment station. It would appear that most research workers

TABLE VI-35

Type of Contact Former IRRI Research Trainees Have HAd With Farmers

Type of Contact	Number of Trainees Answering		
	Yes	No	Total
A. Advising individual farmers on improved practices	99	37	136
B. Working with farmers by conducting production plots or field trials on their farms	65	71	136
C. Conducting field days and/or training programs for farmers	52	84	136
D. Organizing village/community meetings to advise groups of farmers on improved practices	42	94	136
E. Making radio reports, writing news reports, etc. for farmers	30	106	136

Note: Number of trainees not having contact with farmers = 98 (of which 18 respondents were temporarily students).

in this group are having at least minimum levels of contact with farmers which would suggest a continuing interest in solving farmer production problems.

Publication Record of Former IRRI Research Trainees[11]

Trainees were asked to indicate if they had written any professional or technical papers or reports during the past two

[11]The problem of assessing work performance and output of technical personnel conducting knowledge generating, technology developing and/or extension activities is difficult. As discussed

years (1971-72) for publication in a professional journal, for presentation at a professional meeting, for use by the national program, or for use by agricultural producers.

TABLE VI-36

Publication Record of Former IRRI Research Trainees During the Past Two Years (1971-72)

Type of Written Output	Number of Trainees Writing Each Type	Total Papers Written/ Published	Average Number/ Trainee
Technical Papers--for publication or presentation	130	370	2.85
Technical Reports--for internal use by the national program	74	194	2.62
Extension bulletins, etc.--for use by agr. producers	36	91	2.53
Teaching materials, training manuals, etc.	48	100	2.08

Total Number of Trainees Reporting Some Type of Written Output: 161

To summarize, it was found that 130 IRRI research respondents have written technical research papers for publication or presentation

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(Footnote 11 continued) earlier, the publication of research papers, extension bulletins, etc. is one objective measure of technical output. However, given the types of research and extension activities being emphasized in the respective training programs, this measure is considered to be inadequate for this study (see page 168). Therefore, the type and level of trainee publications is presented here, but the overall work performance of active rice research and production workers is considered to be most accurately measured by the number of research experiments, field trials and production plots actually completed.

during the past two years (1971-72). Since only 137 participants reported that they are mainly engaged in research work in their present job assignment (see Table VI-31), it would appear that a high proportion of research trainees are at least partially engaged in experimental research.[12] In contrast to this finding, however, was the fact that 36 former research trainees have written extension bulletins during the same time period. While this is a relatively small group, it does demonstrate that some former trainees are directly involved in the process of extending new improved rice technology to agricultural producers.

Factors Influencing the Use of Training

This section will examine how different factors have affected the use of training, both during the first year after returning home from the training program and in the trainee's present job. First an examination will be made of the effect of returning to an unexpected job, on the use of training during the first year. Next, the reasons why some former trainees are no longer actively engaged in rice research and production programs will be examined. Finally for those trainees who are still engaged in wheat research and production programs, a third perspective will be to examine specific organizational factors within the national program that may have limited their use of training; as well as to determine if any of these

[12] The same data for the CIMMYT wheat group found 98 trainees mainly engaged in research, with 30 participants producing technical research papers during the same period.

factors are directly associated with work performance (amount of work completed).

Effect of Job Returned to on the Use of Training During the First Year After Returning Home

As stated earlier, the individual research project approach is considered by IRRI staff members to be a more flexibile approach to research training; therefore, as long as the trainee works in a rice research program, he should be able to make some use of his training. Earlier it was found that 14% of the trainees had experienced unexpected personnel action during the first year after returning home. The following table is presented to determine what effect unexpected personnel action has on use of training and in doing so to indirectly test the hypothesis suggested by some IRRI scientists that the project approach is more flexible than a more specific job approach to training.

TABLE VI-37

Effect of Unanticipated Job Changes on Use of Training During the First Year After Returning Home for IRRI Research Trainees

	Use of Training During First Year			
Job Returned To	little or no use	some use	full use	totals
Returned to Expected Job	8	83	83	174
Returned to Different Job	9	12	6	27
Totals	17	95	89	201

Number not working prior to entering the training program: 30

Number not responding 3

$X^2 = 22.43$ with 2 df (P = .0000 **)

If the research project approach to training is somewhat flexibile in preparing participants for different types of job assignments in their national programs, then it would be expected that the level of training use for those trainees returning to different jobs would tend to parallel the level of use of those respondents returning to expected jobs. This is clearly not the case. In fact in comparing these data with the results found in the CIMMYT study (see p.172) it appears that the research project approach to training is as job specific as the on-the-job training approach used at CIMMYT, but job specific for a different type of research assignment.

It should be noted that the 30 participants who indicated that they were not working prior to the training program were not included in the statistical analysis of this table. The reason for exclusion was the fact that many of these respondents were students prior to entering the training program, and there was no way to determine which respondents returned to expected or different jobs. It appears that this group is more or less randomly distributed in the use of training, with 7 respondents reporting little or no use, 12 trainees reporting some use of training and 11 trainees reporting full use of training. The proportion of trainees in this third category who reported some or full use of their training is somewhat higher than those trainees returning to different jobs; still, 23.3% of this group are failing to make use of their training, as contrasted with only 4.6% of those respondents who returned to expected jobs.

To conclude, it is apparent that most trainees return home to expected jobs, and in these cases the use of training is very high. While in many cases trainees who return to unexpected jobs can make some or even full use of their training, clearly the level of training use is highest when trainees return to expected job assignments.

Reasons Why Research Trainees Are Not Presently Working in Rice Research and Production Programs[13]

One concern of this study was to determine why trainees had left rice research and/or production work since returning home. In particular the concern was to determine if such departures were organization-directed, or if the trainees were transferring on their own initiative in response to favorable career opportunities.

Next trainees were asked to indicate how long they worked in rice research and/or production programs after returning home, before they left this work.

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[13] The data used in this section was derived from the question: "If you are not working in rice research and/or production at the present time, please indicate how many months or years you worked with a rice program--after you returned from IRRI--before you left these duties; and the major reason for leaving this work." Since some trainees (for example: statisticians, agricultural economists, university lecturers, etc.) may not be assigned directly to a rice research or production program, there was some confusion as to whether this question should be completed. Therefore, of the 234 respondents in the research trainee group, 154 indicated that they were directly involved in rice research and/or production programs; with 67 indicating that they were not presently involved in rice related work; and with the other 13 respondents apparently falling into this in-between category.

TABLE VI-38

Reasons Why Former IRRI Research Trainees Have Left Rice Research and/or Production Programs

Reasons for Leaving	N	%
Routine Transfer--organization directed	11	17.5%
Opportunity for Promotion	9	14.3%
Opportunity for Salary Increase	9	14.3%
Didn't Work After Returning Home	6	9.5%
Other	6	9.5%
Temporary Departure--left to continue education	22	34.9%
Totals	63	100.0%
Not Applicable	167	
Number Not Responding	4	

TABLE VI-39

Number of Years IRRI Research Trainees Worked in Rice Research and/or Production Programs Before Leaving These Duties

Number of Years	N	%
Never Worked in Rice Program	17	25.4%
Worked 1 year	12	17.9%
Worked 2 years	13	19.4%
Worked 3 years	8	11.9%
Worked 4 years	8	11.9%
Worked 5 years	8	11.9%
Worked 6 or more years	1	1.6%
Total	67	100.0%
Not Applicable	167	

The trainees who have voluntarily left or who have been transferred out of rice research and/or production programs worked on the average of 2.1 years in these programs before their departure. Approximately one-third of this group were temporarily in graduate school; so, it is likely that the majority of these respondents will eventually return to rice research work.

It must be expected that a certain number of trainees will drop out of rice research and/or production work after returning to their home countries. The objective, insofar as the training institution is concerned, is to minimize the number of participants falling into this category. While the dropout rate with the IRRI research training group is relatively low, IRRI should carefully scrutinize any training candidates who are not working prior to entering the training program. It appears that those trainees who are unemployed or who are in school prior to entering the training program are more likely to drop out of rice research work than are those trainees who are employed in rice research and/or production programs before coming.

Limiting Factors to the Use of Training

Trainees were asked if there were any factors that may have limited their use of the training after returning home. The purpose of requesting this information was three-fold: (1) to determine which factors, if any, were more common to returning trainees; (2) from this information to determine what supporting role, if any, the training institution might play in helping to reduce the effect of

specific limiting factors; and (3) to assess the influence of specific limiting factors and overall problem load on the trainee's use of training and actual work performance. First the limiting factors to the use of training will be considered:

TABLE VI-40

Limiting Factors to the Use of Training for IRRI Research Trainees (in ranked order of difficulty)

Limiting Factors: Lack of:	Number of Respondents Indicating: the Limiting Factor Was: (N=234) somewhat of a problem	a serious problem	weighted total[14]
Adequate Budget	85	64	213
Adequate Laboratory or Greenhouse Facilities and Equipment	86	56	198
Adequate Transportation	69	39	147
Adequate Maintenance of equipment and facilities	79	34	147
Subordinates with Adequate Training	78	28	134
Essential Operating Supplies and Materials	62	33	128
Support from Higher Officials in the Organization	66	30	126
Authority to Incorporate the New Techniques and Methods into the National Program	63	19	101
Support and Help from Trainee's Immediate Supervisor	54	17	88
Adequate Experimental Land, Field Plot Equipment, machinery, etc.	47	17	81
Colleague Interest in New Ideas and Techniques Learned at IRRI	39	11	61

[14] A statement describing how limiting factors were weighted is given on page 174 of Chapter IV.

Like most research workers around the world, the inadequacy of research funds was listed as the most serious factor limiting their use of training, as well as the size and scope of their research programs. But the more important question is what they would use these funds on if they were available. To obtain an indication of these resource needs, it is necessary to examine what other factors are more frequently mentioned.

Since a substantial proportion of research trainees receive at least part of their training in the laboratory or greenhouse while at IRRI and since about one-third of those participants actively engaged in rice research at the present time are mainly involved in laboratory or greenhouse work, it was not unexpected to find that the lack of laboratory and greenhouse equipment and facilities was mentioned as being the most serious limiting factor. Since the lack of experimental equipment and facilities was anticipated as being a serious problem, a second series of questions was asked to obtain more information about this limiting factor.

While the following table refers to the availability of any type of scientific equipment that former trainees need in their present job, it is apparent (given the findings in Table VI-40) that the lack of laboratory and greenhouse equipment and instruments is a serious limiting factor to nearly one-fourth of all IRRI research trainees and is somewhat of a problem for another 37% of trainees in this group. Given the number of respondents reporting active research programs in both rice and other crops (137 respondents), it must be concluded that nearly all former trainees, who work in research programs, are

TABLE VI-41

Availability of Scientific Equipment That IRRI Research Trainees Used in Their Training and Need for Their Present Job Assignment

Availability of Scientific Equipment	N	%
Trainee Didn't use scientific equipment as part of his technical training at IRRI	39	17.1%
Equipment was used and was available in national program when trainee returned home	60	26.3%
Equipment was used and has become available in national program since the trainee returned	65	28.5%
Equipment was used, but still is not available in national program	64	28.1%
Totals	228	100.0%
Number not responding	6	

being limited to some degree by the lack of laboratory and greenhouse facilities and equipment.

The lack of adequate transportation and the lack of adequate maintenance of equipment and facilities were the next two factors mentioned most frequently by trainees, followed by the lack of subordinates with adequate training. An important point to note, in reviewing this over-all list of limiting factors, is that physical resource problems are mentioned more frequently by trainees as being limiting than organizational support factors. Although certain limiting factors may be more frequently mentioned by trainees than others, this does not necessarily imply that these factors have an important influence on the effectiveness of these individuals.

Therefore, multiple linear regression analysis was carried out to determine which factors, if any, were more commonly associated with low use of training and low work performance as dependent variables.

The same basic procedures were followed in this analysis as was done in Chapter IV with the CIMMYT wheat group; but, as was the case in the CIMMYT analysis, it became clear that there are many organizational and personal factors, in addition to the training program itself, that are influencing the use of training and work performance. It appears possible to increase the level of predictability of these models by including other variables. However, many of these factors are beyond the direct control of the training institution; therefore, constructing such models would serve little purpose to the institute and could detract from the more important findings of this study. Thus these models are not included.

Summary and Conclusion

The IRRI research training program is an integral part of the institute's on-going research activities and its international cooperative programs. The institute is committed to strengthening national rice research programs, and IRRI's leaders see the research training program as a resource that national programs can use in up-grading the technical proficiency of their staff members.

The major thrust of IRRI's research training approach centers around the research project. Trainees are expected to focus on a serious production problem in their home country and

to carry out one or more research projects that will generate possible solutions to these problems.

Research trainees work closely with a senior IRRI scientist and frequently carry out research projects that are an integral part of their advisor's over-all research program. In many cases these research efforts result in jointly authored research papers that report important research findings and contribute to the growing body of knowledge about rice production in the tropics.

While some advanced research trainees come to IRRI to learn specific research skills and techniques, or to conduct research projects that are beyond the scope of their national program (because of the lack of adequate scientific equipment), the major objective of the project approach is to provide participants with a solid research experience--teaching him each step involved in planning, designing, executing and reporting on a research project. At each step of the way, the trainee learns by doing. In terms of educational objectives, the major focus of the project approach is on analysis and using research as a tool to generate new information about production problems and their possible solution, and/or to test suspected relationships between production factors. The knowledge that is generated from these projects may be used in the development of improved rice technology that will increase rice production in the tropics.

There are two exceptions to the project training approach which should be noted. Non-degree trainees in varietal improvement do not conduct research projects, but work largely as research

assistants in IRRI's on-going rice breeding program. Again these trainees learn by actually carrying out each task involved in a varietal improvement program and, at the same time, become familiar with the germ plasm currently being used in the IRRI program. The second exception to the project approach is found in the agricultural engineering department. In this case, engineering technicians are given short-term training, so that they can evaluate and demonstrate IRRI-developed machinery in their own countries under local conditions.

While research trainees work in specific disciplinary departments at IRRI, the Saturday Seminar has become the institutional mechanism by which both trainees and staff learn recent research findings in other departments. By sharing research results with staff members in other disciplines, scientists can frequently gain new insights and perspectives on important rice production problems; and, these interchanges sometimes lead to cooperative efforts between departments. When these multidisciplinary team efforts occur, they demonstrate to trainees how an effective research institute can organize its scientific resources in different ways to solve production problems.

The institute is conveniently located next to the University of the Philippines College of Agriculture, and about one-third of IRRI's research trainees combine a M.S. degree program at the college with their research training at the institute. By combining a degree program with a solid research experience, IRRI scientists believe these trainees will be able to perform more effectively after returning home and, in addition, will have the necessary educational

credentials to move into leadership positions in their respective national programs. In regard to this second point, it should be noted that IRRI research trainees are a highly educated group, with only 31% having less than a M.S. degree by the time they leave the institute. In addition, about one-half of this latter group (with B.S. degrees) have gone on for M.S. degrees since leaving the institute, with another 65 former research trainees having received or presently working toward Ph.D. degrees.

Former IRRI research trainees have reacted in very positive terms when assessing their training experience at the institute. While IRRI has selected both research and teaching personnel from national institutions, more than 90% of all research trainees indicated that the training had been of use to them since returning home. In addition, approximately 71% of former trainees--who were working when the survey was taken--are still actively involved in rice research or production programs.

While the project training approach was initially considered to be less job specific and a more flexible approach to research training than was the on-the-job training approach used in the CIMMYT training program, trainees who returned home to jobs other than those expected were much less likely to use their training in the first year than those trainees who return home to expected job assignments. In fact, these data for the IRRI research trainees closely parallel the CIMMYT findings, suggesting that the project approach is also job specific, but job specific in terms of experimental research.

In considering the main educational objective associated with the project training approach (i.e. analysis), it seemed quite consistent to expect trainees to continue working in experimental (analytical) research after returning home. To verify this hypothesis, the work behavior of former trainees was examined to determine which types of research were being emphasized. As expected, more knowledge generating types of research (field, laboratory and greenhouse experiments) were being carried out than research activities associated with the direct development of rice technology (agronomic field trials and genetic crosses).

Another factor that was considered in determining the type of research being emphasized by IRRI research trainees was the form of research output. Since research papers are a primary output from knowledge generating types of experimental research, this factor was examined to further document research worker behavior. First it was found that 106 research trainees had been able to publish (or present) a total of 187 research papers based on their research work at IRRI. Second, trainees were asked if they had been able to publish or present any research papers based on research conducted since returning home. In the two year period (1971-72) 130 former trainees produced 370 technical papers. Given the fact that only 154 trainees indicated that they were actively engaged in rice research and production programs when the survey was taken and that only another 5% of former trainees were working in other crop research programs, it must be concluded that knowledge generating types of experimental research are heavily dominating

the work behavior of former IRRI research trainees.

The results of the IRRI research training program appear to be very consistent with the educational objectives being pursued. Whether or not these consequences are intended or unanticipated is not perfectly clear. It does appear, however, that research trainees are following the behavioral pattern being set by many of the senior scientists at IRRI.

As mentioned earlier, several senior scientists distinguished IRRI as a "research institute," rather than a crop improvement program. This distinction, the heavy emphasis on project research, and the volume of research publications resulting from this work, all indicate that considerable emphasis is being given to knowledge generating types of research. The point in making this observation is not to be critical of IRRI's research programs or to suggest that this is an improper orientation for the institute itself. The point is to ascertain the impact and influence of this research orientation and normative structure on the work behavior of research personnel in national programs.

Before moving further into these issues and the implications of the IRRI research training approach with regard to helping solve serious institutional problems being faced by national rice research programs in many less developed countries, it is necessary to first understand the role and relationship of the rice production training program within IRRI's over-all institution building strategy. Therefore, the next chapter will provide a detailed examination of this program; then, in the last chapter, both training programs will

be considered together in assessing their impact on national rice research and production programs.

CHAPTER VII

THE IRRI RICE PRODUCTION TRAINING PROGRAM

Introduction

By 1964 it was apparent that new high yielding rice technology would soon be available for use in the tropics. The next problem was to begin training production specialists (extension workers) so that they could competently demonstrate the use of modern rice technology to agricultural producers and assist them in its adoption.

During the first two years of the rice production training program, the focus was on training national rice production specialists. Realizing that a large number of production specialists would be needed in each country--many more than IRRI could possibly train at the institute--the training focus was shifted to "train the trainers." The plan was for these trainers to return home to set up in-service training programs for extension workers. It was expected that these second generation trainees would become the rice production specialists who would directly assist local agricultural producers in adopting the improved rice technology.[1] Before moving into a detailed

[1]For an excellent descriptive summary of the development of the rice production training program, see: Vernon E. Ross, "The Evolution of the IRRI Rice Production Training Program." Paper presented at the Annual Rice Research Conference at the International Rice Research Institute, April 19-23, 1971. Note this paper is attached as Appendix .

description of this training approach and the result achieved, the procedure will be to digress briefly and outline the source of data to be used in this analysis.

Methodological Note[2]

As was the case for the two preceding groups, the data to be used in the following analysis was derived from a mail survey questionnaire that was sent to nearly all former IRRI Rice Production Trainees. The criteria used in determining which trainees should be included in this study was that the former participant be back home on the job at least six months and that his training be more than two months in length. Since the regular training programs for rice production trainees have been either 6 or 12 months in length, all rice production trainees from less developed countries, through the year 1971, were included in the survey.

Names and addresses of former trainees were obtained from the Rice Production Training Office. It was determined that 201 participants should be included in the study. Of this group IRRI did not have addresses for 6 trainees, and it was subsequently learned that 3 trainees were deceased. Furthermore, after sending out the questionnaires, 8 were returned in cases where the trainee had moved and had left no forwarding address. Therefore, of the 201 trainees who

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[2]For a more detailed description of the research methodology employed in this study, including copies of the data collection instruments, please see the attached appendix entitled: Summary of Research Methodology.

had participated in this program, 184 individuals were assumed to have received the questionnaire. Of this group, 153 trainees completed and returned the questionnaires resulting in a response rate of 83.2%, or the highest response rate of the three groups. However, of the 153 questionnaires received, three were received too late to be included in the analysis. Two respondents were IRRI research trainees after completing their rice production training; so, they were included in the analysis of the research group. Therefore, a total of 148 respondents are actually used in the evaluation and analysis of this particular program.

During the 7 training years included in this study, IRRI has trained rice production trainees from 24 different less developed countries. The following table presents the number of trainees and respondents from each of these countries.

Although the first rice production training program had only 5 participants, IRRI has gradually increased the class size to an average of 35 trainees for the annual 6 month training program. The following table indicates the number of rice production trainees and respondents completing their training by year.

With this introduction to the number of trainees and respondents included in the rice production training program, the discussion will move ahead and consider the training approach being used in this program. The procedure to be followed in studying this approach will be the same as that used in the analysis of the other two training programs in that the training experience will be divided into the three stages of training (as discussed in Chapter II).

TABLE VII-1

Number of Rice Production Trainees & Respondents by Country

Country	Number of: Trainees	Respondents
Japan	1	1
Korea	2	2
Fiji Islands	5	5
Philippines	65	47
Malaysia	3	2
Indonesia	19	15
South Vietnam	10	7
Khymer Republic	2	1
Laos	8	6
Thailand	9	7
Burma	6	4
Bangladesh	4	2
India	23	20
Sri Lanka	22	20
Pakistan	9	7
Nepal	2	0
Iraq	1	1
Afghanistan	1	0
Tanzania	2	2
Kenya	1	0
Sierra Leone	1	1
Ghana	1	1
Nigeria	2	1
Sudan	2	1
Totals	201	153

TABLE VII-2

Number of IRRI Rice Production Trainees and Respondents (from less developed countries) By Year

Year	Number of: Trainees	Respondents
1964 (six month program)	5	4
1965 (twelve month program)	5	5
1966 (six month program)	4	0
1966 (twelve month program)	23	15
1967 (six month program)	32	22
1968 " " "	31	24
1969 " " "	34	28
1970 " " "	33	24
1971 " " "	34	31
Totals	201*	153

*Note: During the program years of 1967-70, eight additional trainees (citizens of the United States) participated in the rice production training program.

These stages are: (1) pretraining, (2) training and (3) post-training. The procedures and objectives associated with each stage of the training process will be discussed and survey data presented to further document these activities. The final sections will deal with the use of training on the job after returning home and an analysis of those factors influencing the use of training and work performance.

Pretraining

The pretraining period includes the application and selection process. Where the institute has entered into a formal cooperative agreement with a national government, the institute frequently works through its local representative to identify and assess technical manpower deficiencies and to work with national program leaders in screening and recommending individuals for the rice production training program.

In cases where IRRI does not have a local representative, potential trainees may (1) be identified by IRRI officials visiting rice production programs in a particular country; (2) be recommended by an official of another international agency; (3) be recommended to IRRI by a national government; or (4) potential trainees may apply directly to IRRI.

Selection Criteria and Procedures

Generally the procedures followed and the criteria used in the selection of rice production trainees are the same as those used for research trainees[3] with a few minor differences. The first difference reflects the fact that rice production training is a formally organized program (apart from IRRI's on-going research programs) that is limited to a maximum of 35 trainees per course. Because of this limitation and the demand for this type of training,

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[3]See pages 211-13 for a description of the general procedures and qualifications used in the selection of IRRI trainees.

only the best qualified candidates from each nation are accepted. Second, in cases where the best qualified candidates from certain countries do not have the required B.S. degree, this selection criterion is relaxed. Third, while the program is primarily designed for extension specialists in rice production, some IRRI representatives nominate research workers for this type of training. While it was not possible to learn first hand why these research nominations are made, the apparent behavioral objective being sought is to provide these research workers with direct and practical experience in growing a rice crop using modern, high yielding technology.

Selection Criteria Used in National Programs

As discussed earlier, there was considerable concern expressed by officials at one center to learn more about the selection criteria and procedures used in national programs and to determine if and to what extent these factors affected the use of training and work performance of former trainees after returning home. Therefore, rice production trainees were asked to assess the importance of a number of different factors that may have been instrumental in their selection.

The perceived importance of different factors in the selection of rice production trainees closely follow the results found in the IRRI research training group. As expected trainees most frequently mentioned that they needed the training to do their job more effectively. Educational qualification and language ability were next, with more

TABLE VII-3

Assessed Level of Importance of Specific Factors Used in the Selection of IRRI Rice Production Trainees

Factors	Level of Importance: (N=148) Very Important	Somewhat Important	Not Important	Don't Know or N.A.
Needed the training to do my job more effectively	80.5% (107)	16.5% (22)	3.0% (4)	(15)
Educational Qualifications	51.5% (69)	45.5% (61)	3.0% (4)	(14)
Language Ability (English)	53.2% (67)	38.1% (48)	8.7% (11)	(22)
Member of an accelerated rice improvement program	43.0% (49)	36.0% (41)	21.0% (24)	(34)
Seniority--next in line for training	19.5% (24)	36.6% (45)	43.9% (54)	(25)
Good Relations with Officials in His Organization	10.9% (12)	22.7% (25)	66.4% (73)	(38)
Good Relations with Local IRRI Representative	10.0% (10)	12.0% (12)	78.0% (78)	(48)

than 90% of the respondents placing some importance on these two factors. Rice production trainees, like the IRRI research group, mentioned seniority much less frequently as being an important factor in their selection, than was the case with the CIMMYT wheat training group (see page 109).

While other types of selection criteria, such as personal qualities and intellectual ability, may be identified through field interviews, these characteristics could not be measured and

presented in a study of this type. It is possible, however, to present some other types of quantitative data which will help to give a descriptive profile of those production trainees that are being selected for training at IRRI.

IRRI Rice Production Trainee Profile

The mean age of rice production trainees when entering the training program was 32.4 years. Of the 148 respondents included in this study, all but two trainees were males.

The educational prerequisites to enter any of IRRI's training programs are quite explicit (i.e. a B.S. degree is required). However, as mentioned earlier, for rice production trainees from certain countries, this degree requirement is relaxed. The following table indicates the number and percent of trainees at each educational level at the time of acceptance into the rice production training program.

Trainees were asked several questions to ascertain their level of contact with rural life and agricultural production while growing up. First trainees were asked to describe the place where they lived most of the time until they were 12 years of age.

Next trainees were asked to give their father's occupation or profession, to determine how many trainees came from farm families.

Finally respondents were asked to indicate if the source of their families' income, when they were growing up, was mainly from agricultural sources; and, if so, to indicate the primary source of that income.

TABLE VII-4

Highest Educational Level Attained by IRRI Rice Production Trainees Prior to Entering the Training Program

Highest Educational Level Attained	N	%
Less than B.S. Degree*	32	22.4%
B.S. Degree or Equivalent	93	65.0%
M.S. Degree or Equivalent	16	11.2%
Ph.D. Degree	2	1.4%
Total	143	100.0%
Number not responding	5	

*Most of these respondents held Agricultural School Diplomas, which represents 2-3 years of post-secondary school training in agriculture.

TABLE VII-5

Place Where IRRI Rice Production Trainees Lived Until 12 Years of Age

Place	N	%
Rural	114	77.0%
Urban	34	23.0%
Totals	148	100.0%
Number not responding	0	

While an agricultural background has not been used as a selection criterion for rice production trainees, this group has the strongest rural/agricultural background of the three trainee groups included in this study. Seventy-seven percent of the trainees grew up in rural areas and 45% of the fathers of rice production trainees

TABLE VII-6

Occupation of the Fathers of IRRI Rice Production Trainees

Occupation	N	%
Farmer or farm worker	62	43.7%
Agriculturist (research or extension worker)	3	2.1%
University Educator	1	0.7%
Elementary or Secondary Teacher	20	14.1%
Profession (Medicine, Law, etc.)	6	4.2%
Government Civil Servant	18	12.7%
Industry (Including the trades)	8	5.6%
Business	18	12.7%
Other (e.g. military	6	4.2%
Totals	142	100.0%
Number not responding	6	

were directly engaged in agricultural work. In addition, fifty-five percent of the respondents indicated that their families had derived the main source of their income from agricultural sources.

All IRRI rice production trainees were working immediately prior to entering the training program, except for three trainees who were students. Of those rice production trainees who were working, 33 respondents (22.8) indicated that they had been working only with rice, with another 96 participants (66.2%) having worked with rice and other crops. Sixteen trainees (11.0%) said that they were not working with rice before coming to the training program. Three students did not respond to this question.

TABLE VII-7

Main Source of Family Income When IRRI Rice Production Trainees Were Growing Up

Main Source of Family Income	N	%
Family owned and rented land	20	13.7%
Family owned and cultivated land	52	35.6%
Family rented or share-cropped land	6	4.1%
Family members worked as agricultural laborers	2	1.4%
Other sources of agricultural income	1	0.7%
Sub-total (agricultural sources)	81	55.5%
Non-agricultural Sources	65	44.5%
Grand Total	146	100.0%
Number not responding	2	

Next trainees were asked to indicate the type of organization they had been working for prior to entering the training program.

TABLE VII-8

Type of Organization IRRI Rice Production Trainees Were Working for When Selected

Type of Organization	N	%
Government Research Organization	30	20.3%
Government Extension Service	80	54.1%
Agricultural College or University	23	15.5%
Company or business	5	3.4%
Other	7	4.7%
Student	3	2.0%
Totals	148	100.0%

Trainees were asked how many years they had been working for their work organization, prior to being selected for the training program. While one respondent had worked 26 years before coming to IRRI for the production training program, the mean number of years on the job was 7.3 years. Next trainees were asked to describe the main type of work that they were engaged in prior to coming to the training program.

TABLE VII-9

Main Type of Work IRRI Rice Production Trainees Were Engaged in Prior to Coming to the Training Program

Main Type of Work	N	%
Mainly Administrative Work	10	7.2%
Mainly Field Research Work	31	22.3%
Mainly Laboratory/Greenhouse Research	4	2.9%
Mainly Field Extension	73	52.5%
Mainly Teaching	21	15.1%
Totals	139	100.0%
Some Combination of the Above Types	6	
Number not responding (students)	3	

These data reflect that only about one-half of the respondents were actively engaged in field extension work prior to entering the training program, but that an additional 22% of the respondents were engaged in field research work. Somewhat unexpected was the fact that 15% of the trainees were mainly engaged in teaching, most at agricultural colleges, before coming to IRRI. The size of this group

will be important when the "train the trainer" data are analyzed later in this chapter.

To summarize, it appears that IRRI is accepting a relatively experienced but diverse group of trainees into its rice production training programs. While the stated objective of the training program is to "train the trainers" of rice production specialists (presumably in national extension organizations), it appears that national programs and IRRI representatives do not reflect this rather narrow behavioral objective when nominating candidates. While the investigator has no empirical data to support the proposition, from talking with IRRI staff members and other individuals familiar with the program, it appears that candidates were nominated for the rice production training program more on the basis of the type of training offered (i.e. the subject matter content in rice production), rather than from the more specific behavioral objective of establishing in-service training programs in each national extension program.

The next section will deal with the actual training itself, focusing on the specific objectives and methodology of the program. This descriptive material will be followed by a general evaluation of the rice production training program by the respondents from the perspective of their job situation after returning home.

Training

The IRRI Rice Production Training Program is generally associated with the behavioral objective of "training the trainers" of rice production specialists. While training trainers is one important

behavioral objective of the program, it is by no means the only one. The Lecture Syllabus for the 1971 Rice Production Specialist Course provides a rather clear list of the types of behavioral objectives being sought by this training program (IRRI, 1971b, p. 4):

> The IRRI Rice Production Specialist Course is designed to develop the trainees after a period of six months to be able to:
>
> 1. Recognize and solve the problems of rice production;
> 2. Conduct scientifically designed applied research enabling them to adjust the package of practices to local conditions;
> 3. Develop and execute efficient extension programs;
> 4. Recognize and apply the important principles of communications to train extension workers and farmers in the new rice technology; and
> 5. Recognize and apply the important concepts of rice science.

In attempting to achieve these specific behavioral objectives, the rice production training program is divided into two distinctly different, but well integrated parts. First there is classroom instruction that focuses on specific cognitive objectives that are directly related to the use of modern rice technology. This formalized training occupies about 50% of the total training time. The other half of the training is spent in field practice (cognitive and psychomotor objectives)--where trainees (1) actually grow a rice crop using the most advanced technology available in the tropics and (2) learn to conduct replicated applied research trials, whereby the trainee can adapt this advanced technology to the local growing conditions in his own country. While affective objectives are not

explicitly mentioned in IRRI's training materials, the investigator found--in talking with Vernon E. Ross, Director of the Rice Production Training Program--that certain types of attitudinal objectives are considered important, particularly in connection with the field practice training. The following sections will consider the two main parts of the rice production training in more detail, focusing on the training objectives and methodology associated with both parts.

Cognitive Objectives

During the first day at IRRI, rice production trainees are given a diagnostic skill and identification test. The purpose of the test is threefold. First to establish a benchmark score for each trainee when he enters the program which measures his ability to identify all types of rice production problems, such as: fertilizer deficiency symptoms, common rice diseases, pests and insects that attack rice plants, as well as many agri-chemicals that may be needed in improved rice production. The second purpose, since most trainees only identify 20-50% of the test items correctly (Byrnes, 1967, pp. 2-5), is to quickly and dramatically demonstrate to each trainee that he has much to learn about rice production and the problems that affect yields. Finally the third purpose, which is accomplished after the trainee successfully retakes the test just piror to leaving the training program, is to give the trainee increased confidence that he can (1) diagnose rice problems correctly and (2) provide farmers with appropriate technical information that will help solve these production problems.

Diagnostic skill training has been given considerable attention in the short term training programs that IRRI has conducted in the past (trainees from these two week programs are not included in this study) and in the training programs returning trainees are expected to conduct in their home country programs. While the ability to identify (recall the name) different rice production problems and materials is certainly a prerequisite for rice production workers, this ability represents the lowest level of understanding within the cognitive domain. Clearly the ability of some trainees to increase their diagnostic test scores from 15-20% to 70-80% in 5 days (Byrnes, 1967, Table 1) represents a rather dramatic, but superficial increase in knowledge about rice production problems. While this training represents much of the content of short term training programs, it represents only the introduction to the 6 month training program. In the rice production (specialist) training program, that this study is directly concerned about, trainees are expected to develop a much deeper understanding of these different problems through a series of well planned lectures, discussions and direct field experience (which will be discussed later under psychomotor objectives).

Throughout the 6 month training program, trainees receive instruction in the classroom that is designed to impart knowledge and technical information about all aspects of rice production as well as information about communication, teaching and extension methods, and information on the economics of rice production, agricultural development, etc. In total about 150 formal classroom presentations are made by members of the IRRI research

staff as well as by faculty members at the University of Philippines College of Agriculture.

The approach used throughout the training program is for the person in charge of each training section (both classroom or field practice) to have clear behavioral objectives that he expects trainees to be able to accomplish after completing the training session. Therefore, at the beginning of the Lecture Syllabus, most instructors presenting lecture/discussion sessions list the cognitive objectives they hope to accomplish.[4] By doing a content analysis of these educational objectives, it was found that approximately 40% of the objectives focused on knowledge recall, 47% on knowledge comprehension, 11% on the application of knowledge and 2% on analysis.

Since most lectures deal with the current state of knowledge in each technical sub-discipline associated with rice production (for example: virus diseases of rice, the genetics of insect resistance in rice, mineral nutrition of the rice plant, etc.), it is obvious that each topic must be covered rather superficially and be limited to the main points of importance. This accounts for the heavy emphasis on the educational objectives of knowledge comprehension and recall. Basically the goal is to provide trainees with the most authoritative and up-to-date technical information and knowledge about rice production in the tropics that is available anywhere in the world today.[5]

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[4]See IRRI, Rice Production Specialist Course Lecture Syllabus, Vol. 1, 1971, pp. 6-36.

[5]It should be noted that in addition to providing trainees with detailed lecture materials, training manuals, research papers and other written materials, IRRI is considering making color video

Psychomotor/Cognitive Objectives

One criticism that has frequently been made about extension workers (and research workers) is that they do not have the basic skills associated with growing a rice crop. Without this ability, it is unlikely that extension agents will be able to convince agricultural producers to use new improved technology. Byrnes summarizes the argument by saying, "It is difficult for one to teach what he does not know!" (Byrnes, 1967, p. 2).

To insure that each trainee can grow a rice crop, using high yielding technology, IRRI has set aside part of its experimental farm for use by rice production trainees. Each trainee, individually or in small groups, is responsible for successfully learning and carrying out each skill associated with producing a crop of rice. To add a little interest and enthusiasm in this particular field exercise, trainees sometimes pit their production recommendations against other members of the training group. During the growing season and at harvest time, production records are carefully kept to determine which trainees are able to produce the highest yields, while keeping their production costs low. This competitive teaching technique encourages trainees to think through their production recommendations, taking into account all the factors that a rice farmer must face, before actually trying out these practices in the field.

(Footnote 5 continued) tapes of these training activities that would make this knowledge and technical information available to training programs in other countries.

Introducing improved technology to small scale agricultural producers frequently increases the economic risk (at least perceived, if not real) faced by adopters. The reason for this increased risk is that in most cases the improved technology requires the use of capital inputs. To obtain these inputs agricultural producers frequently need to obtain production loans. To get these loans, however, they may be required to put up their land as collateral. If the new technology fails to produce the expected additional output, the peasant faces default on his loan and loss of his land. Therefore, before a new package of practices is extended to farmers, it must be carefully developed and well tested. To do this requires the extensive use of replicated applied research trials, carried out under farmer conditions and in farmer's fields.

Production trainees at IRRI learn the latest information about new production technology; but, this technology has been developed under the growing conditions that are found in one region of the Philippines where the rice institute is located. A package of practices that works well for agricultural producers in this region may be somewhat inappropriate for another rice growing region in the Philippines or for conditions found in other countries. Or, as pointed out in the first chapter, production technology is considered to be "location specific" and must be adapted to fit local growing conditions given the availability of inputs and the economic situation (factor costs and price structure) faced by producers.

To enable production trainees to adapt this high yielding production technology that has been developed by IRRI and to meet

the growth environments of their own regions, trainees are given extensive training in conducting applied research trials. Again, as was the case with the high yielding production plots, each trainee is responsible for designing, conducting and reporting on at least three applied research trials. The following is a list of applied research trials grown by the 1971 training group (IRRI, RPTP Project Review, 1972, p. 6).

1. Stand Establishment Applied Research Trial (SEART)
2. Growth Stages
3. Display Plot of IR22
4. Production Plot of IR 127-80-1-10
5. Zero Tillage of Rice
6. Farmers Evaluation of New Selections Applied Research Trial (FENSART)
7. International Rice Variety Display Plot
8. Mini-Kit Rice Variety Applied Research Trial
9. Growth Stages Display Plot
10. IRRI New Selections Applied Research Trial
11. IR24 Production Plot - Row Sown
12. Granular Herbicide Applied Research Trial (GHART)
13. Management Levels (4) Applied Research Trial
14. Tungro Virus Control Project (TVCP)
15. IR24 and C4-63 G - Production Plots
16. Farmers Fertilizer Management
17. Variety x Spacing
18. Production Plot Project
19. Nitrogen x Variety Applied Research Trial (NVART)
20. Furadan Insect Control Applied Research Trial (FICART)
21. Insect Control Applied Research Trial (ICART)
22. Insect Control Display Plot (ICDIP)
23. IR5, IR 1154-243 and IR 1561-156-2 Production Plots

Cognitive/Affective Objectives

To prepare trainees for their expected role as trainers in their national programs, or as extension workers dealing directly with agricultural producers, the training program includes lectures and practical training on communication in general and on teaching

and extension techniques in particular. Trainees are taught to gear their teaching, training and extension activities to specific behavioral objectives in the same manner as is done in the IRRI rice production training program.

Classroom instruction is followed by practical training in the use of these different communication skills. During the latter part of the course, each trainee is required to plan a two week training program for village level extension workers--just as he would expect to carry it out in his home country. Then these plans are integrated and trainees, as a group, actually conduct a two week training program for Philippino farm management technicians (extension workers). Each trainee is responsible for actually handling a one-half day session, during which he presents the appropriate technical material for the short course trainee and, where appropriate, demonstrates and supervises any skill training (field practice) that would be associated with his session. IRRI trainees, therefore, have a chance to gain some practical experience in actually organizing a training program and in practice teaching before returning home.

Training Methodology and Organization

The rice production course is synchronized with the wet rice growing season and starts around the first week of June each year and continues through the end of November. Since the different training methodologies used in this program were included as part of the discussion on educational objectives in the preceding section,

this section will be used to make a few additional observations about the organization of the program.

The rice production training program appears to make good use of different educational methods that are well suited to the different behavioral objectives being sought by the IRRI staff. In addition, these different methods are fully integrated and logically structured within the overall program, so that, for example, classroom instruction on a particular subject is coordinated with practical training in the field. While the program may have lacked careful organization in earlier years (Castro, 1972, pp. 51-52), more recently the program has become so well organized that trainees know tentatively at the beginning of the program and specifically at the beginning of each week, what lectures and field activities will be covered each day, as well as when assignments will be due, examinations held, etc.[6]

The stress in all of the practical training activities is on "learning by doing." Each trainee must learn and develop sufficient skill competency in each production or applied research skill to be able to successfully carry out the required field assignments. Thus trainees move beyond merely talking about the new production technology and the relevant field skills and practices, but are able to actually get into a rice paddy and demonstrate these skills and techniques to farmers or other extension workers.

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[6]See the Tentative Program Schedule in the 1971 Rice Production Specialists Course Lecture Syllabus, Vol. I, 25 pages.)

Conclusions

The rice production training program originally focused on training rice production specialists who could extend improved rice technology from the research station to agricultural producers. It soon became apparent, however, that IRRI did not have the resources or capability to train the numbers of rice production specialists that would be needed in each national program. Therefore, in 1967 the overall behavioral objective of the program was changed to that of "training the trainers" of rice production specialists. These trainers in turn were to return home and establish in-service training programs for both village level extension workers and for farmers. In 1970 the course content of the program was substantially modified to reflect IRRI's intention to train trainers.

While communication skill training now reflects the behavioral objective of training trainers, the actual technical training portion of the program has not changed significantly, except that the rice technology continues to improve and the technical content of the course reflects these changes. Classroom instruction (cognitive objectives) is well integrated with the field practice (cognitive/psychomotor objectives) portions of the training, and trainees emerge from the program with the most up-to-date information on improved rice technology for the tropics with the skills and confidence to grow a rice crop using this improved technology. In addition, they have the necessary applied research skills to test and adapt this improved technology to the growing conditions that are faced by agricultural producers in their home countries and regions.

Prior to moving on to the next section of this study, it should be noted that the investigator had little direct contact with this particular training program and most of these observations have been synthesized from secondary sources and from discussions with the director of the rice production training program. Therefore, it is possible that certain other important points may have been inadvertantly omitted. In order to provide the reader with the supplemental information on this training program, a copy of Vernon E. Ross' paper "The Evolution of the IRRI Rice Production Training Program" has been included in the appendix of this thesis.

Trainee Feedback on Training Program

The trainees selected for IRRI's rice production training program represent diverse organizational backgrounds and were involved in widely differing job assignments prior to entering the training program (see section on rice production trainee profile). In spite of these differences, IRRI gives each trainee solid technical training and prepares each trainee to communicate this technical information and these production skills to other rice production workers in the national program and to farmers. This next section will present empirical data based on how trainees assessed various aspects of the training they received at IRRI.

Adequacy of Pre-arrival Information

Trainees were asked to assess the adequacy of their information about the training program before coming to the training site.

Of the 144 trainees who responded to this question, 26 respondents (18.1%) indicated that the information was very adequate; 58 trainees (40.3%) said the information was somewhat adequate; 38 trainees (26.4%) said it was somewhat inadequate and 22 trainees (15.3%) said the pre-arrival information was very inadequate. Next trainees were asked to indicate which of several types of information they had received prior to their departure from their home country. With about 42% of the respondents indicating that their pre-arrival information was inadequate, this would suggest that IRRI should carefully examine its current procedures of informing candidates about the training program. To determine which types of information are currently being received by trainees, respondents were asked to check from a list the types of materials and information received before their departure.

TABLE VII-10

Types of Information Received by IRRI Rice Production Trainees Before Coming to the Training Site: N = 148

Types of Information Received	N	%
Specific objectives of the technical training program	65	43.9%
Outline of the proposed plan for the technical training	55	37.2%
IRRI administrative policies and regulations for trainees	43	29.1%
Relationship between the objectives of the technical training program and the national rice research program	74	50.0%
Information about the Philippines (N=103)	40	38.8%
Trainees not receiving any information	29	19.6%

These data indicate that about 20% of rice production trainees are not receiving any pre-arrival information; and, for those trainees who do receive information, there does not appear to be any consistency as to the type of information received. Since IRRI does not provide production trainees with much descriptive written information about the program, it is likely that trainees are receiving information about individuals with both first and second hand knowledge about the program. Given the on-going continuity of the program and the availability of excellent informational services at IRRI, this is one deficiency that could probably be resolved quickly and easily with a descriptive booklet on the program.

From the information received in the preceding table, a scale was developed to quantitatively measure the total amount of information received by each trainee and to differentiate among trainees as to the amount of information received. The mean of this scale for IRRI rice production trainees was 1.9 types of information received, the same as for the research group.

It was expected that as the program became better organized, trainees would receive more complete pre-arrival information; but, an analysis of the data showed that there was little difference between years in terms of the amount of information received by trainees. Again this would probably reflect the fact that trainees are still receiving most of their information about the program from varied and indirect sources.

To find out where pre-arrival information was coming from, trainees were asked to indicate the best source of information about

the training program before their departure. Of those trainees responding, 35% indicated that either their supervisor or some other official in their work organization was their best source of information, with about 30% mentioning an IRRI official or representative. Former trainees were mentioned by 15% of respondents as being their best source of information, with the remainder of trainees mentioning the training brochure (5%) and officials in several different international organizations (15%) as their best source of information.

Trainees' Reaction to the Actual Training Program

First trainees were asked to indicate how they found the level of the training program, considering their previous background and experience. Since trainees with somewhat diverse levels of training are accepted into the training program, which offers a uniform course of study, it was anticipated that the level of training may be a little low for those trainees with more advanced training. Approximately 20% of the respondents found the level of the training too elementary for their previous background and experience while 76% of the trainees indicated that the level was about right for them. The other 4% of the respondents classified the training as too difficult. In addition, it was found that trainees entering the training program with higher levels of education (M.S. and Ph.D. degree level) were more inclined to assess the program as too elementary compared with those trainees with lower levels of education (statistically significant at the .05 level).

This finding raises a question as to whether or not M.S. and Ph.D. level participants belong in this particular training

TABLE VII-11

IRRI Rice Production Trainees' Assessment of the Level of Training by Educational Level When Entering the Program

Previous Educational Level	Level of the Training Was: Too Elementary	About Right	Too Difficult	Total
Less than B.S. degree	5	25	2	32
B.S. degree	14	75	4	93
M.S. or Ph.D. degree	9	9	0	18
Totals	28	109	6	143
Number not responding				5

$X^2 = 9.46$ with 4 df (P = .0506, *)[7]

program, given the train-the-trainer focus. Since research workers generally tend to have higher educational levels than extension workers and given the fact that about 20% of the rice production trainees are research workers, a second tabulation was made to determine if, in fact, it was primarily research workers that were assessing the training as being too elementary.

These data indicate that the type of work trainees were doing prior to entering the training program has no apparent effect on how participants found the level of training. In particular, research workers were no more likely to assess the training as being too elementary than were field extension workers. Therefore, these findings lead to the conclusion that previous educational level is the

[7]See footnote 5 on page 142 for an explanation of the statistical notations associated with this chi-square test of significance.

TABLE VII-12

IRRI Rice Production Trainees' Assessment of the Level of Training by the Type of Work the Trainee was Engaged in Prior to Entering the Training Program

Previous Type of Work Trainee Engaged In	Level of the Training Was: Too Elementary	About Right	Too Difficult	Total
Mainly Administrative Work	-- (0)	100.0% (10)	-- (0)	100.0% (10)
Mainly Field Research	19.4% (6)	77.4% (24)	3.2% (1)	100.0% (31)
Mainly Laboratory or Greenhouse Research	-- (0)	100.0% (4)	-- (0)	100.0% (4)
Mainly Field Extension	23.3% (17)	69. % (51)	6.9% (5)	100.0% (73)
Mainly Teaching	19.1% (4)	80.9% (17)	-- (0)	100.0% (21)
Combination of Two or More of the Above	16.7% (1)	83.3% (5)	-- (0)	100.0% (6)
Total	19.3% (28)	76.6% (111)	4.1% (6)	100.0% (145)
Number not responding				3

more important factor in explaining how trainees assess the level of difficulty of the rice production training program.

Next trainees were asked if the balance between theoretical instruction and practical training was about right. Sixteen respondents (11.0%) found the training too theoretical, 109 trainees (75.2%) said the balance was about right and 20 respondents (13.8%) said they thought the training was too practical. Three individuals failed to respond to this question. These responses indicate that the rice production training program has a fairly good balance between

theoretical (classroom instruction) and practical (field practice) training.

Then trainees were asked if the technical skills and techniques they learned at IRRI were appropriate for the jobs to which they expected to return.

TABLE VII-13

Appropriateness of Technical Skill Training for IRRI Rice Production Trainees

Technical Skills Were	N	%
Very Appropriate	100	68.0%
Somewhat Appropriate	41	27.9%
Inappropriate	6	4.1%
Totals	147	100.0%
Number not responding	1	

It appears from the trainees' assessment of the technical skills and techniques taught during the training program that they were generally quite appropriate for the jobs to which they expected to return.

Trainees were also asked to assess the level of skill competency that they had time to achieve while in the training program. Since it was found that CIMMYT wheat trainees with more advanced educational backgrounds achieved a higher level of skill competence than trainees with less education, this same relationship was tested for the rice production trainees.

TABLE VII-14

Skill Competence Achieved by IRRI Rice Production Trainees by Previous Educational Level

Previous Education Level	Became Familiar with the Skills	Learned the Skills	Mastered the Skills	Total
Less than B.S. degree	8	12	12	32
B.S. degree	14	45	33	92
M.S. degree or higher	4	5	7	16
Totals	26	62	52	140
Number not responding				8

X^2 = 1.86 with 4 df (P=.7620 n.s.)

The IRRI rice production trainees developed fairly high levels of (self-assessed) skill competence with 37.1% indicating that they had mastered the skills, 44.3% indicating that they had learned the skills and 18.6% indicating that they had only become familiar with the skills. It should be pointed out that a higher proportion of rice production trainees indicated that they had mastered the skills taught, than was found in the CIMMYT group.[8] This finding would be consistent with the relationship established earlier in Chapter IV about the CIMMYT training that linked previous educational level with the level of skill competency achieved. In that case, CIMMYT trainees with higher educational backgrounds developed higher levels of skill competency

[8]For the CIMMYT group, 29.7% of the respondents indicated that they had mastered the skills, 53.1% had learned the skills and 17.2% had become familiar with the skills.

that trainees with lower levels of education (statistically significant at the .01 level). This relationship, however, was not found in the case of rice production trainees (see X^2 value in Table VII-13 above). These findings considered together, suggest that skill training within the CIMMYT program is somewhat more difficult (at least for CIMMYT trainees) than are rice production skills for IRRI rice production trainees. It is possible to infer from this conclusion that the type and depth of skill training within the rice production training program is most appropriate for the types of trainees presently being selected for this particular training program.

Next, trainees rated the adequacy of supervision and direction given by the senior staff. To determine if there had been any perceived changes by trainees as to the adequacy of senior staff supervision over time, these data were tabulated by the year when the training was received.

The majority of rice production trainees assess senior staff supervision and direction as being adequate; 55.1% of former trainees assessing it as very adequate, 32.7% assessing it as somewhat adequate and only 12.2% indicating that senior staff direction and support was less than adequate. The year 1969 was a transitional year in the leadership of the rice production training program and the data reflect the settling in problems that can be expected to occur when there is insufficient overlap between incoming and departing training directors.

Trainees were asked to rate the appropriateness of the technical skills that they received at IRRI, in regard to the job to which they

TABLE VII-15

Adequacy of Senior Staff Supervision and Direction by the Year When the Training was Received for IRRI Rice Production Trainees

	Senior Staff Supervision & Direction Was:			
Years Training Received	Less than Adequate	Somewhat Adequate	Very Adequate	Total
1964-66	1	0	7	8
1967	4	5	21	30
1968	4	6	19	29
1969	5	13	8	26
1970	2	9	12	23
1971	2	14	14	30
Totals	18	47	81	146
Number not responding				2

$X^2 = 13.93$ with 10 df ($P = .1762$, n.s.)

expected to return. Respondents were generally very satisfied in that 100 trainees (68.0%) felt the skills were very appropriate; with another 41 respondents (27.9%) indicating that the skills were somewhat appropriate. Only 6 trainees (4.1%) indicated that the technical skills and techniques learned were inappropriate for the job to which they expected to return.

Trainees were asked which aspect of the overall training experience at IRRI they felt most satisfied with. The following factors were among those mentioned most frequently by respondents.

Then trainees were asked to indicate which aspect of the training experience at IRRI they were least satisfied with. Again

TABLE VII-16

Aspect of the IRRI Rice Production Training that Former Trainees were Most Satisfied With

Aspect Most Satisfied With	N	%
Practical Field Training	33	24.7%
Applied Research Methods	16	11.9%
Extension and Communications Skills	15	11.2%
Diagnostic Skills	15	11.2%
Effective Classroom Instruction	13	9.7%
Technical Skills Learned	6	4.5%
Increased Knowledge about Rice	6	4.5%
Good Staff Relations	5	3.7%
Field Trips	5	3.7%
All Aspects of the Program	5	3.7%
Other (factors mentioned fewer than 3 times)	15	11.2%
Totals	134	100.0%
Number not responding	14	

those factors mentioned most frequently are presented.

It was found (Table 16) that trainees were generally most satisfied with the practical field training they received in rice production skills and in those other technical skill areas that were covered intensively during the overall training program, namely: applied research skills, extension and communications skills, and diagnostic skills. Table 17 indicates that trainees were generally least satisfied with other technical aspects of their rice production

TABLE VII-17

Aspect of the IRRI Rice Production Training Program Former Trainees were Least Satisfied with

Aspect Least Satisfied with	N	%
Technical Training: Lack of sufficient time spent on particular training areas	26	21.8%
Technical Training: Poor or Inadequate Instruction in a Particular Area or By A Particular Staff member	22	18.5%
Trainee Felt He Was Being Used for Manual Labor in the IRRI Production Program	13	10.9%
Inadequate Administrative Support: unsuitable living environment/food; inadequate stipend/allowances	9	7.6%
Other (factors mentioned fewer than 3 times)	19	16.0%
Trainee Expressed His General Satisfaction With All Aspects of the Training Program	30	25.2%
Total	119	100.0%
Number not responding	29	

training--those covered rather superficially by outside instructors (primarily IRRI research staff members). In these cases the complaints were generally that the topic was not covered in adequate depth, or that the speaker was ineffective in communicating his material.

Trainees' Overall Evaluation of the Training Program

For this section, trainees were asked to evaluate the IRRI rice production training program from several different perspectives.

These responses serve to summarize how trainees presently assess their previous training experience at IRRI.

First, trainees were asked to assess their technical training considering their previous training and experience. Ninety-nine respondents (68.3%) indicated the technical training was very appropriate, with another 39 (26.9%) assessing it as somewhat appropriate. While two respondents were undecided (1.4%), only 4 trainees (2.7%) termed the training as somewhat inappropriate for their previous training and experience, followed by 1 respondents (0.7%) who thought the training was very inappropriate for his background.

Next, trainees were asked to assess the technical training, considering their home country conditions.

TABLE VII-18

Appropriateness of Technical Training Considering the Home Country Conditions of IRRI Rice Production Trainees

Level of Appropriateness	N	%
Very Appropriate	81	55.9%
Somewhat Appropriate	57	39.3%
Undecided	5	3.4%
Somewhat Inappropriate	1	0.7%
Very Inappropriate	1	0.7%
Totals	145	100.0%
Number not responding	3	

Trainees were then asked to indicate how helpful the technical training at IRRI had been in furthering their own personal career plans. Seventy-nine respondents (54.1%) considered the IRRI training as being very helpful to them, with another 40 trainees (27.4%) rating the training experience as being somewhat helpful. Twenty-four trainees (16.4%) indicated that the experience had made little difference in furthering their career plans, while 3 trainees (2.1%) felt the training had been detrimental to their careers.

Trainees were also asked to assess the administrative support (for example: living accommodations, allowances, transportation and other services) they received during all phases of their training program. Again the responses were generally favorable, with 83 respondents indicating that they were very satisfied, 33 trainees indicating that they were somewhat satisfied, 15 trainees taking a neutral position, 13 trainees expressing some dissatisfaction and finally with 3 trainees indicating that they were very dissatisfied.

Next, trainees were asked to give an overall assessment of their total training experience at IRRI.

Finally, trainees were asked to assess the extent to which the training experience at IRRI had made a difference in their ability to help solve the agricultural problems of their home countries.

Those trainees who felt the training had made some or an important difference in their ability were then asked to explain why they felt this way. The reason most frequently mentioned was that the training had "increased their technical skills, knowledge and ability" (35 respondents). The next reason most frequently given

TABLE VII-19

IRRI Rice Production Trainees' Level of Satisfaction with the Overall Training Program

Level of Satisfaction	N	%
Very Satisfied	94	63.9%
Somewhat Satisfied	51	34.7%
Neutral	1	0.7%
Somewhat Dissatisfied	1	0.7%
Very Dissatisfied	0	--
Totals	147	100.0%
Number not responding	1	

TABLE VII-20

Extent to Which the IRRI Rice Production Training Made a Difference in the Trainees' Ability to Help Solve Agricultural Problems

Change in Ability (self assessed)	N	%
Little or no difference	8	5.4%
Some difference	57	38.5%
Important difference	83	56.1%
Totals	148	100.0%
Number not responding	0	

was that trainees felt "better able to solve the production problems that confront rice farmers" (27 respondents), followed by "increased confidence and enthusiasm" (22 respondents) and "better able to teach others" (16 respondents). All of these reasons appear to reflect the main behavioral objectives of the IRRI rice production training

program, as described earlier in this chapter.

In summary, it appears that IRRI rice production trainees have evaluated their previous training experience i very positive terms--from several different perspectives. In fact, of the three training groups included in this study, the rice production training program received the most positive rating from the participant's point of view. In particular, over 95% of the respondents assess the subject matter content as being more or less appropriate for their previous background and experience and for their home country conditions. Also most impressive is the fact that nearly all rice production respondents indicated that they were generally satisfied with their overall technical training at IRRI. While there are some minor problems that IRRI rice production trainees have identified, particularly in terms of the technical training given by certain IRRI research scientists, it must be concluded that former trainees are quite satisfied with their previous training experience and that no basic changes in the structure, content or methodology of the program appears warranted, at least from the participant's point of view.

Post-Training

One function of a training institution is to help the trainee translate his new skills and knowledge into new behavioral patterns once back home on the job. This support may be as little as just letting the trainee know that IRRI is still interested in what he is doing and has not forgotten him, to a fully developed cooperative program that involves a locally assigned IRRI representative--

providing material and financial support. The purpose of this section is to give a general picture as to the types and amounts of follow-up contact individual rice production trainees have had with IRRI since returning home.

Correspondence

Trainees were asked if they had written to and received letters from the IRRI Rice Production Office and IRRI officials since returning home. Fifty-three percent of former rice production trainees indicated that they had written to IRRI staff members since returning home. The average number of letters written per trainee for this corresponding group was 5.1 letters. Approximately 57% of the respondents indicated that they had received letters from IRRI officials, with a mean of 5.8 letters being received by each trainee in the corresponding group.

Visits

Next trainees were asked if they had been visited by an IRRI scientist or official since returning home. Out of the 143 trainees who responded to this question, 41 or 28.7% indicated they had never been visited since returning home. Among the 102 trainees who had been visited, the mean number of visits per trainee was 2.7 visits.

Seventy-eight trainees indicated that they worked in national programs where an IRRI representative or a team of IRRI scientists was assigned.[9] Sixteen trainees or 20.5% of this group said they

[9]Note: The 47 Philippino respondents were not included in these tabulations.

had never been visited by the IRRI representative or scientist during the past year. For those trainees who had been visited, the mean number of visits per trainee was 2.9 visits. In certain cases this last figure may be biased downward since some trainees work in daily contact with a locally assigned IRRI staff member.

IRRI Publications

One of the easiest communication mechanisms by which IRRI can inform former production trainees of new developments in rice research and production is through IRRI's publications. These publications consist of newsletters, annual reports and technical papers, booklets and books. In addition, in recent years, IRRI has made available training materials to some former trainees, particularly those who are working in national training programs. The number of former participants receiving information and support through regular mailings of IRRI publications, however, has not been very high. Only 61 trainees (42.4%) indicated that they have been receiving IRRI publications on a regular basis. Of the other 83 trainees responding to this question, 33 respondents (22.9%) said they were not on IRRI's mailing list, with another 48 trainees (34.5%) being unsure whether or not they are still receiving publications from IRRI. As noted earlier, all of the trainees responding to this survey were added to IRRI's mailing list; so, the effectiveness of this follow-up mechanism should be greatly improved at the present time.

Post-Training Workshops

Although IRRI holds international symposia from time to time and has annual international rice research meetings, these activities usually involve high level research scientists rather than former trainees. To date there has been no systematic effort to bring former rice production trainees together to up-grade their previous training. Even so, 13 trainees (8.8%) (primarily from the Philippines) have managed to attend one or more post-training meetings at IRRI.

Use of Training

Given the stated objective of the IRRI Rice Production Training Program, which is to train trainers, this program can be considered as quite "job specific." If the trainee returns to the type of job that he was trained for, then it would be expected that he would make full use of his training experience. As will be shown later, however, trainees do not always return to the jobs for which they are specifically trained or that other factors modify the extent to which the trainee is able to use his training after returning home. In this section, the purpose is mainly to examine the major dependent variables being used in this study that characterize various aspects of the trainees' use of the training.

The Trainees' Self Assessment

Trainees were asked to assess how much of the training they were able to use during their first year on the job after returning to their home country.

TABLE VII-21

Use of Training by IRRI Rice Production Trainees During Their First Year Home on the Job

Level of Use	N	%
Little or no use	15	10.3%
Some use	49	33.6%
Full use	82	56.1%
Totals	146	100.0%
Number not responding	2	

Later, trainees were asked to assess the extent to which they are using the training in their present job, the purpose being to determine if the training became less relevant and less useful to the trainee as time passed.

TABLE VII-22

Use of Training By IRRI Rice Production Trainees in Their Present Job Assignment

Level of Use	N	%
Little or no use of training	13	9.3%
Some use of training	59	42.1%
Full use of training	68	48.6%
Totals	140	100.0%
Number not responding (mainly students):	8	

Although the proportion of rice production trainees reporting full use of training has declined slightly over time, trainees making full use of their training--as assessed by themselves--still remains higher

than for the other two training groups included in this study. Again, when cross-tabulating these two variables, it was found that there was some instability within cells, particularly among those trainees that made full use of their training during the first year after returning home, then slipped into lower use categories in their present job assignment. In both time frames, however, trainees making some or full use of their training has remained around 90% of the overall respondent group.

Trainee Job Assignments as an Indicator of of Level of Training Use

In considering trainees' self assessment of their use of training, it is impossible to differentiate between direct and indirect use of training. For example, while all trainees have been trained in rice production and communication skills (and in later years have been given practice in training skills), some respondents have now moved into administrative positions in extension, are managing experiment stations, etc. Many of these respondents indicate that while they are not working directly in rice production, they are still making some or even full use of their training. In these cases it is assumed that the use of training is more indirect, than direct. While any use of training is considered to be desirable and preferred to no use; the direct use of training is considered to be much more desirable than indirect use, because of the institution building perspective being used in this study. In other words, the impact and use of training--as an institution building

tool--is taken to be largely dependent on trainees doing what they were trained to do. In this section the use of training will be largely assessed from the point of view of the direct use of training.

Job Assignment Returned to Following the Training Program

Trainees were asked if they had returned to the job that they had expected before their departure. This information was tabulated with a second question that asked if this was the same type of job assignment the trainee had performed before coming to the training program. The objective was to determine if trainees had returned to the jobs they expected and if those were the same or different jobs than they had performed prior to the training experience.

TABLE VII-23

Job Returned to by Type of Job for IRRI Rice Production Trainees

Job Returned to	Same Job	Somewhat Different Job	Very Different Job	Totals
Trainee returned to the job he had expected	59	49	14	122 (84.1%)
Trainee did not return to the job he had expected	9	8	6	23 (15.9%)
Totals	68 (46.9%)	57 (39.3%)	20 (13.8%)	145 (100.0%)
Number not responding				3

As the data indicate, about 84% of the trainees are returning to jobs that they expected to be doing prior to their departure, with the

remaining 16% being subjected to unexpected personnel action. In this latter group a few trainees were transferred out of, or for various reasons, left rice production programs after returning home; while others, expecting to be assigned as rice production specialists, were in fact returned to their previous jobs, some in general extension work. The important point is that the vast majority of trainees did return to their old jobs or expected new jobs presumably where their newly acquired skills could be utilized.

Present Job Assignment

Trainees were asked to give the descriptive title of their present job assignment, to determine if they are working in the skill area for which they were trained and if they are still working in rice production programs.

These data indicate that only about 13% of former rice production trainees are currently working in training positions dealing with rice production. Another 24% of former trainees are presently working as rice extension specialists and 5% more are working in general agricultural extension.

Although IRRI's training objectives focus on up-grading the rice production and communication skills of extension workers (either as trainers or as production specialists), it was found that about 28% of former trainees are working in some type of agricultural research capacity. Of particular interest was the fact that 14 trainees are working as rice breeders and another 9 trainees are employed as rice agronomists. This rather large group of rice

TABLE VII-24

Present Job Assignments of Former IRRI Rice Production Trainees

Job Category		N	%
Rice Training Specialist		19	12.8%
Rice Extension Specialist		36	24.3%
Agricultural Extension Worker		8	5.4%
Extension Administrator		7	4.7%
Rice Breeder		14	9.5%
Rice Agronomist		9	6.1%
Research Specialist:		8	5.4%
Agronomy (other crops)	2		
Soils Specialist	3		
Entomologist	1		
Agr. Engineer	1		
Agr. Economist	1		
Agricultural Research (general(:		10	6.8%
Experiment Station Manager	6		
Research Technician	4		
Farm Manager		3	2.0%
Agricultural Salesman		1	0.7%
University Professor/Lecturer		4	2.7%
Secondary School Teacher		2	1.4%
Administrative Position in Agriculture		13	8.8%
Other		3	2.0%
Student		11	7.4%
Totals		148	100.0%

production trainees who are working in research assignments raises obvious questions about the selection criteria used and/or about the behavioral objectives of the training program. The fact that about 25% of rice production trainees were engaged in research work prior to the training program would tend to indicate that their current job assignments do not represent a change in work behavior on their part.

The remaining trainees are mainly engaged in some type of administrative work, managing large farms, or are teaching in secondary schools or universities. In some of these cases, trainees indicated that they were using the training, but it would appear that in most cases this would constitute an indirect use.

Former trainees were then asked to name the principal crops they work with in their present job assignments. Forty-five respondents (32.8%) indicated that they only work with rice while another 66 trainees (48.2%) indicated that they work with both rice and another crop(s). Thirteen trainees (9.5%) said that they do not work with any crops in their present jobs, while another 5 respondents (3.7%) said they only work with crops other than rice. Eight trainees (5.8%) failed to respond to this and several other questions dealing with rice production work; therefore, it is unlikely that trainees in this group are involved in this type of work at the present time. The 11 respondents who indicated that they are presently attending the university could not respond to this question, but it is likely that many of these individuals will return to rice production programs after completing their degree programs.

Conducting Training Programs in Rice Production

Trainees were asked if they had helped train other research or extension personnel in specific work skills (that they had learned at IRRI) since returning home. The obvious point of this question was to determine how many trainees have been able to multiply their IRRI training among their colleagues and/or village level extension workers in their national program. Before presenting the data received, it should be pointed out that given the responses to other parts of this general question, this specific question was sometimes misinterpreted to include training activities for agricultural producers as well. Therefore, the responses to this specific question should be interpreted in this broader context.

TABLE VII-25

Training Activities of Former IRRI Rice Production Trainees

Trainee Has Participated In	N	%
Both organized training programs for organizational personnel (and farmers) and in informal, on-the-job training sessions for colleagues and subordinates (and in certain cases farmers)	84	57.1%
Organized training programs for organizational personnel (and farmers)	15	10.2%
Informal, on-the-job training sessions for colleagues and subordinates (and in certain cases farmers)	16	10.9%
Participant has had no opportunity to train others	32	21.8%
Totals	147	100.0%
Number not responding	1	

While on the surface it would appear that former IRRI rice production trainees have been very successful in organizing and/or in working in rice production training programs, the actual extent to which these activities have been implemented is not known.[10] Therefore, the trainer concept will be discussed briefly, and, what little data are available will be presented.

The objective underlining the train-the-trainer program, as conceived by IRRI, is to obtain a multiplier effect of the training, particularly among village level extension workers, within each national program. The goal is for each participant to train, for example, several dozen or several hundred village level workers in the use of the improved rice technology, so that these extension workers in turn can extend the new technology to the farmers they work with directly.

The investigator visited the national in-service training institute at Peradeniya in Sri Lanka which, among its many other training activities, has developed a well organized second generation rice production training program. Generally these rice production courses are one week in length for agricultural and village level extension workers and one day in length for farmers.

In terms of the number of people trained, the institute is doing a very impressive job. In 1972 the institute provided nearly 10,000 man days of training in rice production for extension workers and farmers (Personal interview with D.W. Sirinayake, Agricultural

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[10]Due to the unique characteristics of the group of trainees included in the pre-test of the questionnaire, it was not possible to

Officer In-charge, In-Service Training Institute, Nov. 15, 1972). However, the quality of this training program and its impact on the work behavior of extension workers is open to question. While the training sessions include, what are termed "practicals," there appeared to be a minimum amount of time actually spent on "learning by doing" rice production skill activities and more emphasis on information giving and demonstrations.

Another problem that this particular national training program is facing is the regular turn-over of the institute's staff. Dr. Ernest Abeyratne, Deputy Director of Extension in Sri Lanka, feels that the department "can't keep these fellows in training positions for a long time. They must 'flow through' to higher positions in the department" (Personal interview with Dr. Abeyratne, Nov. 15, 1972). Therefore, the program needs a continuing supply of newly trained rice production specialists who can serve in these training positions. This approach would result in a continuing infusion of newly trained and enthusiastic trainers, but it is questionable how long IRRI will be able and willing to supply trainers for this program. Another related problem concerns the possible lack of problem continuity that will result by following this approach. After interviewing several members of the in-service training staff, this investigator was left with the impression that every year or two, agricultural instructors (Extension Workers) are sent back to the institute for an additional

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(Footnote 10 continued) anticipate that participants in different work situations would misinterpret these questions on training activities.

week of rice production training, but basically receive an up-dated version of the same rice production course--from the newest group of IRRI returnees. In other words, because of the lack of staff continuity within the training program, there could be considerable repetition in these annual one week short courses.

This research was unable to generate sufficient reliable data that would begin to measure the extent and impact of second generation rice production training programs for extension workers. Observations by the investigator and those reported in by Donald Green, in his study of Indian returnees,[11] indicate that a majority of former trainees have participated in rice production short courses since returning home, but that in most cases these training activities are not the main thrust of the participant's job assignment. Furthermore, it would appear that many trainees are experiencing certain difficulties in organizing these training efforts around the important "learning by doing" training approach, difficulties that must be resolved before the effectiveness of these training efforts can be assured. Since the train-the-trainer objective is an essential link in IRRI's training strategy to up-grade the technical and communication skills of extension workers, it is strongly suggested that IRRI conduct an indepth study of these second generation training programs to find out what progress has been made and how this approach can be improved.

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[11] See Donald G. Green, "The Experiences of Fourteen Returnees From the International Rice Research Institute," (New Delhi, India: The Ford Foundation, 1970).

Other Information on Trainee's Present Job Assignment

In addition to determining how many former trainees are working in rice production programs at the present time and what their descriptive job titles are, trainees were also asked a number of questions to elicit more information about their current job assignments. First trainees were asked to indicate the type of work organization they are presently working for.

TABLE VII-26

Organizations Where IRRI Rice Production Trainees are Presently Employed

Type of Organization	N	%
Government Research Organization	28	20.0%
Government Extension Service	67	47.9%
Agricultural College or University	17	12.1%
Company, Business or Industry	8	5.7%
International Organization (mainly IRRI)	7	5.0%
Other Government Organizations	7	5.0%
Other	6	4.3%
Totals	140	100.0%
Number not responding (including students)	8	

Then trainees were asked to describe the main type of work involved in their present position.

The preceding two tables as contrasted with Tables VII-8 and 9 in this chapter indicate that there has been little change among rice production trainees that were engaged in research

TABLE VII-27

Main Type of Work IRRI Rice Production Trainees Are Presently Engaged In

Type of Work	N	%
Mainly Administrative	30	21.4%
Mainly Field Research	29	20.7%
Mainly Laboratory/Greenhouse Research	5	3.6%
Mainly Field Extension	38	27.2%
Mainly Teaching or Training	30	21.4%
Some Combination of the Above Types	8	5.7%
Totals	140	100.0%
Number not responding (including students)	8	

organizations and research work prior to coming to the training program, but that the numbers of trainees that were conducting field extension work prior to the training has declined by about 48%. While some of these trainees have moved into teaching and training positions (an increase of 9 trainees), the major move has been to administrative work (an increase of 20 trainees). Also it is interesting to note that about 10% of former trainees have left their previous employers to join IRRI or different government organizations.

Respondents were asked one final question to determine how stable their job assignments have been since returning home. In particular, trainees were asked if they were still working for the same organization that they were with prior to entering the training program.

TABLE VII-28

Job Stability of IRRI Rice Production Trainees Since Returning Home

Trainee Is Working For	N	%
The same organization that he was with prior to entering training	101	72.1%
A different organization than he was employed by prior to entering training	36	25.7%
Trainee was not working prior to entering the training program (students)	3	2.2%
Totals	140	100.0%
Not applicable or not responding	8	

About one-fourth of IRRI rice production trainees have joined different work organizations since returning home. It should be noted this level of job instability is about the same as that found within the IRRI research group (24.1%), but both IRRI groups are somewhat less stable than the CIMMYT group (only 12.7%) of CIMMYT trainees have changed organizations). In the next section the reasons why trainees have left rice production work will be examined.

Finally, trainees were asked to describe the level of their current position within their work organization. The purpose of this question was to determine if former IRRI rice production trainees are moving into leadership positions in their work organizations.

To summarize the information presented about job assignments of former rice production trainees, it was found that 84% of the respondents returned (the first year) to jobs that they had

TABLE VII-29

Level of IRRI Rice Production Trainee's Present Job With His Work Organization

Level of Job	N	%
Policy Level	4	2.9%
Senior Level	44	32.1%
Middle Level	74	54.0%
Lower Level	15	11.0%
Totals	137	100.0%
Not applicable or not responding	11	

expected before joining the training program. When the survey was taken, 81% of the respondents indicated that they were working directly in or were in some way associated with rice production programs. However, when examining the types of job assignments presently being carried out by rice production trainees, only about 42% were working in positions that are directly associated with the stated behavioral objectives of the program (training rice production specialists and trainers). This conclusion is not to imply that the rice production training is not appropriate for or of use to the rice research workers (another 28% of the trainees) in the program. In fact, after considering the findings of the IRRI rice research training program, IRRI might well consider expanding this type of production training for rice research workers. The fact remains that this particular program is designed for and has the stated behavioral objective of training extension personnel in rich production and to find, for

example, nearly 10% of former trainees active in rice breeding research work raises serious questions, either about the selection procedures followed or the logical consistency of this program; or about the possible inadequacies of the training program in varietal improvement.

Assessing Job Performance

Since the primary concern of this research is with building strong national research and production programs and the effect of training on the work behavior of former participants, the next section will examine the types of rice research, development and extension activities that former participants have carried out during the last year (1972). For a background statement which helps explain why the following assessment system was developed and used, please see pages 163-64.

Present Research, Development and Extension Activities

Trainees were asked to indicate how many research experiments, applied research trials and production plots they had worked on and helped complete during the last main rice growing season in their home country. Of the 148 respondents, 40 indicated that during the past year they either had not worked directly in rice research and/or production programs or were university students. For the remaining 108 participants, who indicated that they had worked in rice research and/or production programs, the actual number of experiments, replicated applied research trials and high

yielding production plots were averaged (for this sub-group) to give the mean number completed per trainee.

TABLE VII-30

Mean Level of Research and Production Activities Completed by Those IRRI Rice Production Trainees Who were Active in Rice Research and Production Programs During 1972

Type of Activity	Number & Percent of Trainees Conducting each activity (N = 108) N	%	Mean Level Per Trainee (N = 108)
A. Laboratory or greenhouse experiments	5	4.6%	0.07
B. On station field experiments	21	19.4%	1.24
C. Genetic crosses	13	12.0%	5.00
D. On station replicated applied research trials	23	21.3%	0.82
E. On farm replicated applied research trials	33	30.6%	3.18
F. On farm high yielding production plots	67	62.0%	11.15

Approximately 73% of former trainees (108 respondents) reported that they were actively engaged in rice research and production activities. An examination of the preceding table gives a direct quantitative measure of the average work performance (i.e. mean number of each activity completed) for each of these 108 trainees. Although 30% or more trainees are conducting applied research trials, clearly the major thrust of work for rice production trainees is in carrying out on-farm high yielding production plots.

While pre-testing the questionnaire in Sri Lanka it became clear that in this particular country, replicated applied research trials were considered to be part of the research organization's responsibility and not an activity extension workers were allowed to carry out (organizational rule). Therefore, it was found that rice production specialists in this national extension program were only allowed to carry out high yielding production/demonstration plots on farms (called non-replicated field test plots). This finding raised the obvious question that if extension workers were not allowed to conduct replicated applied research trials, then why was this activity stressed in the training program. To determine if this organizational rule (preventing extension workers from conducting applied research trials) was in effect in other national programs, each type of research, development and extension activity was cross-tabulated with the type of organization trainees were associated with. These data indicate that some rice production specialists who are working in national extension organizations can and do carry out replicated applied research trials; but, the proportion of extension workers reporting these activities is quite small. Therefore, it appears that in most national programs it is probably difficult for extension workers to obtain the necessary equipment and possibly approval to conduct replicated applied research trials. Thus the task of adapting improved rice technology to local conditions, if it is being done at all, is being largely left to the national research program. Given the amount of attention that is being given to applied research activities by former IRRI research trainees, how adequately this research

TABLE VII-31

Numbers of Trainees by Organizations Conducting Each Type of Research, Development and Extension Activity and the Mean Number of Activities Completed in Each Category

Type of Activity		Govt. Research Organ.	Govt. Extension Service	Agr. College or Univ.	Other: agri-bus., IRRI, etc.	Total N
A. Laboratory or greenhouse experiments	(N)	2	-	2	1	5
	(Mean)	(2.5)	-	(1.0)	(1.0)	
B. On station field experiments	(N)	12	1	4	4	21
	(Mean)	(6.5)	(2.0)	(7.0)	(6.5)	
C. Genetic Crosses	(N)	5	2	3	3	13
	(Mean)	(79)	(1.5)	(29)	(18)	
D. On station replicated applied res. trials	(N)	10	6	3	4	23
	(Mean)	(3.6)	(4.0)	(6.3)	(2.5)	
E. On farm replicated applied res. trials*	(N)	9	10	4	10	33
	(Mean)	(8.0)	(17.9)	(14.0)	(3.3)	
F. On farm high yielding production plots	(N)	13	32	11	11	67
	(Mean)	(15.2)	(21.2)	(13.0)	(16.9)	

*Note: Five respondents reported very high numbers of on-farm replicated applied research trials (an average of 43 trials/trainee). There was no way to check the accuracy of the data reported, but these respondents may have been reporting applied research minikits, which are not replicated. If this were, in fact the case, these trials should have been reported in row F, rather than row E. Therefore, the data in Row E, columns 2 and 3 should be read and interpreted with considerable caution.

function is being carried out is open to serious question.

While extension workers are not heavily involved in conducting applied research, a somewhat unexpected finding was that nearly half of the rice production trainees working for national research institutions are conducting high yielding production plots on farms--an activity generally considered to be part of the extension service's responsibility. Evidently there are not organizational rules that are restricting research workers from carrying out this type of activity.

Level and Types of Contact with Agricultural Producers

One of the main tasks of rice production specialists is to work directly with agricultural producers (and sometimes indirectly through village level extension workers) to determine which factors are limiting rice production and to recommend improved rice technology that will enable agricultural producers to economically achieve increased levels of output. To better understand how rice production workers are dealing with their agricultural clientele, several questions were asked to determine their level and type of direct contact with agricultural producers.

Of the respondents, 126 (85.1%), indicated that they had direct contact with farmers during the past year. Of this group, 31 respondents (24.8%) indicated that they worked closely with farmers and averaged several contacts with farmers each week, with some trainees in this group reporting daily contact. Of the remaining participants having contact with agricultural producers,

45 trainees (36.0%) indicated that they have contact with farmers several times per month, while the other 44 respondents (39.2%) r reported their level of contact as being several times per season.

Next, trainees were asked where their contact with agricultural producers had mainly occurred. Seventy-three trainees (57.9%) indicated that their contact had primarily occurred on producer's farms; 17 trainees (13.5%) indicated at meetings; 14 trainees (11.1%) said at the experiment station, while only 4 trainees (3.2%) said their contact had mainly occurred in their offices. Eighteen trainees (14.3%) indicated that their contact had occurred at a combination of the preceding places.

Then trainees were asked to indicate the type of contact they have had with farmers.

TABLE VII-32

Type of Contact Former IRRI Rice Production Trainees Have Had With Agricultural Producers (N = 126)

	Number of Trainees Answering:		
Type of Contact	Yes	No	Total
A. Advising individual farmers on improved practices	84.1% (106)	15.9% (20)	100.0% (126)
B. Working with farmers by conducting production plots or applied research trials on their farms	57.1% (72)	42.9% (54)	100.0% (126)
C. Conducting field days and/or training programs for farmers	61.9% (78)	38.1% (48)	100.0% (126)
D. Organizing village/community meetings to advise groups of farmers on improved practices	51.6% (65)	48.4% (61)	100.0% (126)
E. Making radio reports, writing news reports, etc. for farmers	27.8% (35)	72.2% (91)	100.0% (126)

It was found that about 85% of former rice production trainees are having some type of direct contact with agricultural producers; and, in the majority of cases, this contact is occurring on the producer's farm. The level of contact with farmers varies, depending on the type of work the trainee is now engaged in; but, respondents on the average, mentioned that they were working with producers through about 3 different types of communication mechanisms (see Table VII-32). It would appear that at least 60% of former rice production trainees (those reporting at least several contacts per month) are out working with farmers on a regular basis.

Publication Record of Former IRRI Rice Production Trainees[12]

Trainees were asked to indicate if they had written any extension bulletins, training materials, technical reports and/or research papers during the past two years (1971-72).

Only about one-third of rice production trainees produced any form of written output during the past two years, therefore, this is not an important activity for the majority of trainees. For

[12]The problem of assessing work performance and output of technical personnel conducting knowledge generating, technology developing and/or extension activities is difficult. As discussed earlier, the publication of research papers, extension bulletins, etc. is only one objective measure of technical output. Given the types of research and extension activities being emphasized in the respective training programs, this measure is considered to be inadequate for the needs of this study (see page 168). Therefore, the type and level of trainee publications is presented here, but overall work performance among active rice production workers is considered to be more accurately measured by the number of research experiments, applied research trials and production/demonstration plots actually completed.

TABLE VII-333

Publication Record of Former IRRI Rice Production Trainees During the Past Two Years (1971-72)

Type of Written Output	Number of Trainees Writing Each Type	Total Papers Written/ Published	Average Number/ Trainee
Technical papers--for publication or presentation	23	60	2.61
Technical reports--for internal use by the national program	19	72	3.79
Extension bulletins, etc.--for use by agr. producers	28	87	3.11
Teaching materials, training manuals, etc.	28	118	4.21

Total number of trainees reporting some type of written output: 49

those trainees who are writing papers, reports, bulletins, and training materials, their level of output is considerable, which would indicate that they probably devote much of their time to activities that are directly associated with written output. For the majority of rice production trainees, however, their attention and efforts appear to be largely geared to field research and extension activities.

Factors Influencing the Use of Training

This section will examine how different factors have affected the use of training, both during the first year after returning home from the training program and in the trainee's present job. First, an examination will be made of the effect of returning to a different

job on the use of training during the first year home. Next, an examination will be made to determine the reasons why some former trainees are no longer actively engaged in rice production programs and what these individuals are doing now. Finally, for those trainees who are still engaged in rice production programs, a third perspective will be to examine specific organizational factors within the national program that may have limited their use of training; as well as to determine if any of these factors have directly affected work performance (amount of work completed).

Effect of Job Returned To On The Use of Training During the First Year Home

Since the IRRI rice production training program is considered to be quite job specific in its behavioral objectives, it seemed logical to expect that unless a trainee returned to the type of position (or work) that had been planned prior to his departure, his use of training during the first year would be reduced. As mentioned earlier, approximately 16% of production trainees had experienced unexpected personnel action after returning home. The following table will document the effect of these unexpected job changes on the use of training during the first year.

These data for rice production trainees again substantiate the hypothesis that the use of job specific training (in the first year after returning home) is directly related to trainees returning to their expected job assignments. Therefore, it is imperative that the work organization and the training institution are in close communication,

TABLE VII-34

Effect of Unanticipated Job Changes on IRRI Rice Production Trainees' Use of Training During the First Year After Returning Home

Job Returned To	Use of Training During First Year: little or no use	some use	full use	totals
Returned to Expected Job	7	41	72	120
Returned to Different Job	8	8	7	23
Totals	15	49	79	143
Not applicable or not responding:				5

$X^2 = 15.33$ with 2 df ($P = .0005$, **)

so that a minimum of unexpected and unnecessary job changes occur, particularly during the first year or two after the participant returns home.

Reasons Why Trainees Are Not Actively Engaged in Rice Production Work at the Present Time

One concern of this study was to determine why trainees have left rice production programs since returning home. In particular, the concern was to determine if such departures were organization directed, or if the trainees were transferring on their own initiative in response to favorable career opportunities. As the data indicate, approximately half of those trainees that have left rice production work altogether did so as a result of organizationally directed transfers. The other respondents indicated that they left rice production work because of career and economic opportunities.

TABLE VII-35

Reason Why Former IRRI Rice Production Trainees Have Left Rice Production Programs Since Returning Home

Reasons For Leaving	N	%
Routine Transfer--organization directed	13	32.5%
Opportunity for Promotion	7	17.5%
Opportunity for Salary Increase	5	12.5%
Other	3	7.5%
Temporarily in School	12	30.0%
Totals	40	100.0%
Not applicable	108	

Next trainees were asked to indicate how long they worked in rice production programs after returning home before they left this work.

TABLE VII-36

Number of Years IRRI Rice Production Trainees Worked in Rice Production Programs Before Leaving These Duties

Number of Years	N	%
Didn't work in rice program after returning	10	25.0%
Worked 1 year	7	17.5%
Worked 2 years	9	22.5%
Worked 3 years	5	12.5%
Worked 4 or more years	9	22.5%
Totals	40	100.0%
Not applicable	108	

The trainees who have left rice production programs, worked on the average of 1.9 years in these programs before their departure. Approximately 30% of this group were temporarily in the university, so it is likely that at least some of these respondents will eventually return to rice production work.

As was stated in earlier chapters, it must be expected that a certain number of trainees will drop out of rice production work after returning to their home countries. The objective, in so far as the training institution is concerned, is to minimize the number of participants falling into this category. While the observed number of trainees that have dropped out of rice production work completely is relatively low (28 respondents or about 20%), after carefully analyzing the data, it was found that there were another 18 trainees (about 13%) who have moved into administrative positions. While these trainees still claim direct involvement in rice production programs, by and large they are not directly using the rice production skills that they learned at IRRI. In addition to these complete and partial drop outs are the other marginal cases, such as the farm managers, secondary school teachers, etc. who, while they are still indirectly associated with rice production work, are not directly contributing their skills to the job assignments for which they were originally trained. When all of these cases are added together, then IRRI's rice production trainee drop out rate becomes a more formidable problem--a problem that should receive close attention in the future.

Limiting Factors to the Use of Training

Trainees were asked if there were any factors that may have limited their use of training after returning home. The purpose of requesting this information was three-fold: (1) to determine which factors, if any, were more common to returning trainees, (2) from this information to determine what supporting role, ~~if any,~~ the training institution might play in helping to reduce the effect of specific limiting factors, and (3) to assess the influence of specific limiting factors and overall problem load on the trainee's use of training and actual work performance. First the limiting factors to the use of training will be considered.

In addition to the lack of an adequate budget, which was listed as the most important problem by all three training groups, the lack of adequate transportation was the second most important limiting factor mentioned by rice production trainees. This finding was anticipated since trainees who are working as rice production specialists are expected to be out in the country-side working with farmers. To do this, however, they need some form of adequate transportation, a factor which is frequently available only on a limited basis (i.e. vehicles may be shared with other government agencies), or are quite unreliable (i.e. lack of adequate maintenance and repair of vehicles).

While some rice production trainees mentioned the lack of various physical resources as being limiting to their effectiveness, it was found that this group as a whole tended to mention different organizational support variables as being limiting to their effectiveness

TABLE VII-37

Limiting Factors to the Use of Training for IRRI Rice Production Trainees (in ranked order of difficulty)

Limiting Factors: Lack of	Number of Respondents Indicating the Limiting Factor Was: (N=148)		
	somewhat of a problem	a serious problem	weighted total[13]
Adequate budget	45	55	155
Adequate transportation	45	36	117
Support from higher officials in the organization	40	38	116
Adequate maintenance of equipment and facilities	44	28	100
Subordinates with adequate training	55	22	96
Authority to incorporate the new techniques and methods into the national program	34	29	92
Essential operating supplies and materials	50	21	92
Adequate laboratory or greenhouse facilities and equipment	35	27	89
Adequate experimental land, field plot equipment, machinery, etc.	46	15	76
Support and help from trainee's immediate supervisor	30	20	70
Colleague interest in new ideals and techniques learned at IRRI	42	13	68

[13] A statement describing how limiting factors were weighted is given on page 174 of Chapter IV.

more frequently than the other two training groups. Since extension workers probably have somewhat less autonomy than their research counterparts and since their IRRI training is directed toward behavioral objectives (particularly establishing in-service training programs) that may be beyond the scope of their regular job assignment; this finding may reflect the lack of organizational support some trainees are receiving as they attempt to incorporate their training into their program of work. While organizational support problems can be resolved by the trainee himself, there is much that the training institution can do--in terms of both pretraining and post-training procedures--to help him. In particular IRRI officials can maximize communication with organizational officials, so that these individuals know what the trainee is attempting to do and to seek their support for these activities.

In addition to the question on the different types of limiting factors which may have been a problem for returning trainees, respondents were also asked about the availability of technical instruments and experimental equipment that they needed for their work assignments since returning home.

The preceding question was included in the questionnaire primarily to determine if research trainees from CIMMYT and IRRI were being limited by the lack of scientific instruments and field equipment. Since a minimum amount of technical equipment is used in the training program for rice production trainees, it was expected that this factor would not be much of a problem for this group of respondents. But in examining the data in both Tables VII-37 and

TABLE VII-38

Availability of Technical Instruments and Equipment that IRRI Rice Production Trainees Used in Their Training and Need for their Present Job Assignment

Availability of Technical Instruments and Equipment	N	%
Trainee didn't use technical instruments and equipment as part of his technical training	58	41.1%
Instruments and equipment were used in respondent's training and were available in the national program when he returned home	20	14.2%
Instruments and equipment were used and have become available in the national program since the trainee returned home	36	25.5%
Instruments and equipment were used, but are still not available in the respondent's national program	27	19.2%
Totals	141	100.0%
Number not responding		

38, it appears that certain types of instruments and equipment are still perceived as limiting the effectiveness of about 20% of this training group. Since activities, such as conducting replicated applied research trials, require certain minimal types of experimental field equipment--equipment that would not normally be available in an extension office--this finding probably reflects a real need by active rice production specialists and trainers.

Certain limiting factors may be more frequently mentioned by former trainees than others. This does not necessarily imply that any single, group or total number of factors plays an important role in reducing the effectiveness of rice production workers. To

determine if any factor or group of factors was directly influencing "use of training" and "work performance" as dependent variables, multiple linear regression analysis was carried out, using all of the appropriate independent variables included in the study.

As was the case with the other two training groups, however, there are many different organizational and personal factors, in addition to the training program itself, that are influencing the use of training and work performance. Therefore, while it was possible to identify those factors that were having some influence on the two dependent variables, the amount of variance explained was so small that these models were useless as predictors. While it appears possible to increase somewhat the level of predictability of these models by including other variables, since many of these factors are not under the influence or control of the training institution, constructing such models would serve no practical purpose to IRRI.

Summary and Conclusions

The IRRI rice production training program was established in 1964 in response to a growing need for competent rice extension specialists who could: (1) diagnose serious rice problems, (2) grow a rice crop using the high yielding rice technology that was being developed by IRRI and (3) communicate these skills, methods and techniques to rice producers through efficient extension methods. Later, as it became apparent that IRRI could not begin to train all of the rice production specialists needed by national programs, IRRI shifted its focus to training the trainers of rice production specialists.

The logic of this approach was to create a multiplier effect within each national program, whereby large numbers of field extension workers could be trained to use and demonstrate the new improved rice technology.

The rice production training program is a 6 month course which is conducted during the wet rice growing season beginning in early June each year. The behavioral objectives of the present program in addition to the three original objectives as mentioned above, are that trainees will be able to conduct applied research trials to modify the modern rice technology (package of practices) to fit local growing conditions in their home countries and/or regions, and that they will be able to organize and teach in-service rice production training programs for extension personnel in their home country programs.

To achieve these behavioral objectives, trainees spend about one-half of their time in the classroom learning up-to-date knowledge about modern rice production in the tropics and the other half in the field, practicing this knowledge and acquiring new skills in rice production and in communicating this technical information. One of the most outstanding features of the training methodology is the careful integration of classroom instruction and field practice. Another feature is the overall efficiency of the program.

First, the classroom instruction, which imparts extensive knowledge about all aspects of modern rice production, is carefully organized around and integrated with the practical field training. In this way the knowledge learned in the classroom is directly relevant

to the problems faced in the field. Second, the course is highly efficient in that the entire course is completely organized (i.e. lectures, field practice, field trips, etc. are all scheduled) before the trainees arrive, so that each hour is accounted for in terms of the person(s) responsible and the behavioral objectives to be achieved. In addition, most technical lectures, field practice exercises, etc. are reproduced and made available to trainees so each has a rice production training manual and a complete set of technical lecture notes to refer to both during the training program and after returning home. These features are some of the advantages that can be achieved in a training program that is operated apart from an on-going work situation (as in vestibule training)--where attention does not have to be given to production goals. Some of the weaknesses of this method, in comparison with on-the-job training will be discussed in the last chapter.

Former rice production trainees have reacted in very positive terms to the training they received with nearly every trainee indicating that he was satisfied with the overall training and with approximately 90% of the trainees indicating that they were making some or full use of the training.

While trainees were generally very satisfied with the training they received, the number of respondents indicating that they are presently in job assignments where they can make direct use of their training was less satisfactory. Although 81% of the respondents indicated that they were working in rice production programs, only about 42% were in positions that are directly associated with the

stated behavioral objectives of the program.

In regard to the primary behavioral objective of the program, it was found that only 19 respondents (12.8%) were assigned and working as rice production trainers. Although two-thirds of the respondents indicated that they had worked in organized rice production training programs in their home countries, in most cases these duties were in addition to their regular job assignments. Also from the investigator's observations in the field and Donald Green's study of Indian returnees, it appears that many of these ad hoc rice production short courses are not being organized around the key "learning by doing" approach--using staggered plantings and allowing each trainee to become experienced with each field practice associated with growing a rice crop. To successfully carry out this approach requires careful organization, adequate land and training materials, and the continuing, full time involvement of competent rice production trainers. Where training courses are only an adjunct part of an extension worker's overall program, it is unlikely that such an approach can be successfully implemented. Instead, it appears that most of these ad hoc training courses rely mainly on lectures, information giving, and practical demonstrations. In these cases, second generation trainees are not leaving the training program experienced in growing a rice crop with improved rice technology.

In addition to the 19 respondents who are working as rice production trainers, it was found that another 36 respondents (24.3%) were working as rice extension specialists and another 8 trainees (5.4%) were working in rice production, but as general

extension workers. In all of these cases trainees were considered to be directly involved in assignments that are associated with the behavioral objectives of the program.

One finding which was unanticipated was the relatively large number of research personnel (approximately one-fourth) that are being trained as rice production trainers and specialists. Of particular interest was the fact that nearly 10% of former trainees are currently working in rice breeding. How or why these trainees were selected for this program, rather than the training program in varietal improvement, is unknown. While rice production training is probably quite useful and appropriate for many rice research workers, their selection is quite inconsistent with the stated objectives of the current rice production training program.

The remaining trainees have moved into other types of job assignments since returning home (many in administrative positions), but some of these trainees are still associated with rice production work. Eleven participants are attending the university and its appears likely that many of these will eventually return to rice production activities.

CHAPTER VIII

TRAINING STRATEGIES TO MEET THE TECHNICAL MANPOWER REQUIREMENTS OF NATIONAL RESEARCH AND EXTENSION SYSTEMS

Introduction

One of the most important findings in this study was that work behavior differed widely among the three training groups following their return to national job assignments. At the same time, however, it was observed that there were great similarities between the general background characteristics of trainees in the three groups. Therefore, the objective of this chapter will be: (1) to attempt to develop an adequate explanation for these differences in work behavior by examining the major independent and intervening variables and (2) on the basis of these findings, to clarify the policy implications of different training strategies and to make appropriate recommendations to each center.

It should be made perfectly clear at the outset that the purpose in examining these differences in the work behavior of returned trainees is not to characterize one training program as being better or worse than another program. Rather, the objective is to learn from the strengths and weaknesses of each training strategy. The fact of the matter is that each training program

included in this study is generally well organized and well received by former trainees. To establish this point, two major trainee assessment variables are contrasted in Table VIII-1.

Essentially there is little or no difference as to how individual trainees have assessed their training experience at each institute, as well as their perceived use of the training. Therefore, from the viewpoint of the individual trainee, it is concluded that each training program has been effective in achieving its specified training objectives.

TABLE VIII-1

General Trainee Assessment of Each Training Program

Type of Training Assessment	CIMMYT Wheat Trainees	IRRI Research Trainees	IRRI Rice Production Trainees
Trainee's over-all satisfaction with the training program:			
very satisfied	65.4%	55.6%	64.0%
somewhat satisfied	32.3%	35.5%	34.7%
neutral or dissatisfied	2.3%	8.9%	1.3%
total	100.0%	100.0%	100.0%
Trainee's use of training in his present job assignment:			
full use of training	46.4%	39.4%	48.6%
some use of training	47.2%	55.5%	42.1%
little or no use of training	6.4%	5.1%	9.3%
total	100.0%	100.0%	100.0%

As mentioned above, however, trainees are performing differently in their present job assignments. To distinguish how trainees are behaving differently, the data on individual trainee

work behavior is presented for the three training groups. It should be noted, however, that the data in this following table is based on the subgroups of trainees who actually indicated direct involvement (when the survey was taken) in a wheat improvement, or rice research and production programs. The percentage of trainees indicating such direct involvement for each training group is as follows: CIMMYT wheat trainees: 83.3%, IRRI research trainees: 71.3%, and IRRI rice production trainees: 78.8%.

It is clear from the data in Table VIII-2 that CIMMYT wheat trainees are completing more research activities associated with the development of improved crop technology[1] than are IRRI research trainees.[2] In addition, IRRI rice production trainees are completing substantial numbers of production demonstration plots. While the second finding would be expected, since this is primarily an extension group, developing an adequate explanation for the substantial observed differences between the two research groups is more difficult.

Accounting for Observed Differences in Work Behavior

To account for the observed differences in the behavior of the two research groups, an examination was made of the two

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[1] As defined by the functional model of the research, development and extension process, shown as Figure I-1 on page 15.

[2] An analysis of variance for the three technology development variables--C, D and E--in Table VIII-2 indicates that these differences are statistically significant at the .01 level.

TABLE VIII-2

Overall Work Behavior of Individual Trainees in Each Training Program Group (data reported is the mean level of each activity completed/trainee during the main wheat or rice growing season of 1972)

Type of Activity Completed	CIMMYT Wheat Trainees (N = 105)	IRRI Research Trainees (N = 154)	IRRI Rice Production Trainees (N = 108)
A. Laboratory/greenhouse experiments	1.37	1.61	0.07
B. On-station field research experiments	5.62	3.48	1.24
C. Genetic crosses	227.1	19.9	5.0
D. On-station replicated applied research trials	7.24	1.55	0.82
E. On-farm replicated applied research trials	4.74	1.17	3.18
F. On-farm production/ Demonstration plots	3.71	1.46	11.15

major independent variables: (1) the personal characteristics of individual trainees and (2) the characteristics of trainees in their work organizations; as well as the differences in the main intervening variable--the actual training strategy and approach being employed by each institute.[3]

[3]See Figure II-1 on page 47--a model depicting the role of training in behavioral and organizational change--to see the conceptual framework being used in the following analysis.

Personal Characteristics of Trainees

To explain differences in the work behavior of trainees within training groups, the investigator attempted to develop multivariate linear regression models of key independent variables. As reported in the respective chapters, these attempts were quite unsuccessful since none of the independent variables was found to have any great amount of influence on the dependent variable "work behavior." Therefore, in attempting to explain differences between groups, it seemed appropriate to start by examining these same key independent variables to see if they would explain the observed differences in this main dependent variable. Table VIII-3 summarizes those personal characteristics that might be expected to influence work behavior.

In terms of background characteristics, there are two apparent differences between the two research training groups which could affect work performance. The first, as documented in Table VIII-3 above, is the difference in educational level between the two research groups. Although the IRRI research group is more highly educated, and this factor may influence somewhat the type of research conducted (which does appear to be the case), this factor would not be expected to negatively influence the overall amount of work completed.

The second major difference between the two research training groups is nationality and the possible influence of cultural factors on work behavior. Since the IRRI research group is primarily

TABLE VIII-3

Personal Characteristics of Trainees in Each Trainee Group

Personal Characteristics of Trainees	CIMMYT Wheat Trainees (N = 130)	IRRI Research Trainees (N = 234)	IRRI Rice Production Trainees (N = 148)
A. Mean age when entering the training program (in years):	30.6	30.4	32.4
B. Percentage of trainees who grew up in rural areas	61.4%	59.5%	77.0%
C. Percentage of trainee fathers who were engaged in agricultural jobs	47.5%	36.7%	45.8%
D. Percentage of trainee families whose main source of income was from agricultural sources	47.7%	43.2%	55.5%
E. Educational level of trainees when entering the training program			
Less than B.S. degree	21.1%	1.8%	22.4%
B.S. degree or equivalent	57.8%	62.3%	65.0%
M.S. or Ph.D. degree	21.1%	35.9%	12.6%
Total	100.0%	100.0%	100.0%
F. Present educational level of trainees			
Less than B.S. Degree	20.5%	--	17.5%
B.S. degree or equivalent	41.7%	16.2%	56.6%
M.S. degree or equivalent	27.6%	41.2%	19.6%
Ph.D. degree	10.2%	42.6%	6.3%
Total	100.0%	100.0%	100.0%

from countries in South, South-East and East Asia, and CIMMYT trainees are primarily from North Africa, the Middle East, South Asia and South America, this factor could explain some of these differences in work behavior. Given the fact that there was insufficient

overlap between the two groups to really measure the impact of nationality or culture on work behavior the importance of this influence remains unknown. However, based on the investigator's experience in agricultural training programs where he worked with a wide variety of cultural groups, there was nothing in this experience to suggest that cultural background would have a determining influence on the type and amount of work performed. Instead, it appears necessary to explore other variables which may be more important in explaining these differences.

Characteristics of Trainees in Their Work Organizations

The next set of variables to be examined, in attempting to explain differences in the work behavior of the two research training groups, is the role of the trainee in his work organization at the present time. Table VIII-4 presents data on certain selected variables that could be expected to influence the dependent variable.

While there is no difference between research groups regarding the level of their present positions in their work organizations, there are other important differences which could contribute directly to the observed differences in work behavior. First, there is a substantial difference in the proportion of trainees doing field research work. While the work behavior of IRRI research trainees is dominated by experimental field research (as reported in Table VIII-2), the fact that only about 45% of the IRRI research group (as contrasted with nearly 75%

TABLE VIII-4

Different Variables Depicting the Role of Trainees in Their Work Organization for All Three Training Groups

Characteristics of Trainees in Their Work Organization	CIMMYT Wheat Trainees (N = 130)	IRRI Research Trainees (N = 234)	IRRI Rice Production Trainees (N = 148)
A. Types of organization where trainees are presently working:			
National research organizations	88.0%	56.9%	20.0%
National extension organizations	6.4%	1.9%	47.9%
Agricultural college or university	2.4%	27.3%	12.1%
Other	3.2%	13.9%	20.0%
Total	100.0%	100.0%	100.0%
B. Level of trainee's present position in his work organization:			
Policy level	4.0%	4.7%	2.9%
Senior level	41.9%	46.5%	32.1%
Middle level	50.1%	45.0%	54.0%
Lower level	4.0%	3.8%	11.0%
Total	100.0%	100.0%	100.0%
C. Type of work trainee is engaged in at the present time:			
Mainly administrative work	11.6%	12.1%	22.7%
Mainly field research work	74.4%	44.7%	22.0%
Mainly lab./greenhouse research	6.6%	24.1%	3.8%
Mainly field extension work	5.8%	3.0%	28.8%
Mainly teaching or training	1.6%	16.1%	22.7%
Totals	100.0%	100.0%	100.0%
D. Crops worked with by the trainee in his present job assignment:			
Only works with wheat/rice	71.4%	40.7%	32.8%

TABLE VIII-4 (Continued)

Characteristics of Trainees in Their Work Organizations	CIMMYT Wheat Trainees (N = 130)	IRRI Research Trainees (N = 234)	IRRI Rice Production Trainees (N = 148)
Works with wheat/rice and other crops	19.9%	31.5%	48.2%
Does not work with wheat/rice in his present job assignment	8.7%	27.8%	19.0%
Total	100.0%	100.0%	100.0%

for the CIMMYT group) are engaged in field research would be expected to have an important negative influence on the mean level of activities completed per trainee. Second, the important difference between the two groups in regard to crops worked with (71% of CIMMYT trainees worked full time on wheat research, while only 41% of IRRI research trainees worked full time on rice research) would also be expected to have some influence on the total amount of wheat/rice research completed.

These findings raise two obvious questions. First, why are there such large differences between the two research training groups on these two variables, and second, what actual impact are these differences having on the amount of work completed by trainees.

While there are no clear cut answers to the first question, certain facts are known. First, IRRI selects trainees from educational, as well as research institutions for its research training program. With 16% of former IRRI research trainees now working in teaching positions within colleges of agriculture or universities,

this group accounts for more than half the difference between the CIMMYT and IRRI research groups. Second, of those IRRI research trainees who are doing research work, more than one-third are engaged in laboratory/greenhouse research and this group accounts for the remainder of the difference of those trainees doing field research, between the two research training groups.

Less easy to explain or to account for is the fact that only 41% of the research workers included in the IRRI research group are working full time on rice research; yet most come from countries totally dependent on rice as the major food staple. The only apparent reason that will begin to explain this difference is the fact that the IRRI research group is trained in disciplinary departments and is more highly educated, which again would be an impetus to further disciplinary specialization. Once back home in their national programs, which are concerned with several different crops (rather than a single crop as is the case with IRRI), it appears likely that these scientists may be called on to divide their research time with other crops, in addition to rice. For example, a pathologist may be assigned to study fungus diseases of several economic crops, rather than work on all different diseases of rice, such a bacterial blight, blast (a fungus disease) and tungro (a virus disease).

Trainees who have gone through the CIMMYT training program, which operates within an interdisciplinary research structure, have tended to continue their focus on wheat improvement, rather than specialize on research problems within a particular scientific discipline.

The second question raised above, was to determine how much impact these differences in trainee job assignments, between the two research training groups, is having on the overall work behavior of trainees. To address this question, the procedure was to contrast the work behavior of two subgroups of trainees--those mainly doing field research work and those only working on wheat/rice research--from each of the two research training groups, to determine if the observed differences in work behavior could be explained by either of these two independent variables, or if the differences still persist. The results of these analyses are found in Tables VIII-5 and 6.

As the data indicate, the observed differences in behavior for those research activities associated with the development of improved genetic and production technology (types C, D and E) continue to be present even when considering just those subgroups of trainees that are mainly doing field research and those doing only wheat/rice research, respectively. Therefore, it is concluded that while a smaller proportion of IRRI research trainees are working in field research work and also that a smaller proportion are only working full time on rice research, that these differences in job assignments still do not explain the major differences in observed work behavior between the two research training groups.

To reiterate, it was not possible to account for the differences in work behavior between the two research training groups by considering the two main independent variables: (1) the differences in the personal background characteristics of the individual trainees in each group and (2) the characteristics of trainee job assignments

TABLE VIII-5

Analysis of Variance of the Work Behavior of Individual Trainees Who Are Mainly Working on Field Research For the CIMMYT and IRRI Research Training Groups (data reported is the mean level of each activity completed per trainee during the main wheat or rice growing season of 1972)

Type of Activity Completed	CIMMYT Wheat Trainees (N = 79)	IRRI Research Trainees (N = 72)	t values	Level of Significance[4]
A. Laboratory and greenhouse experiments	1.76	0.61	1.1068	n.s.
B. On-station field research experiments	6.82	4.07	1.7757	n.s.
C. Genetic crosses	279.5	26.3	5.8646	* *
D. On-station replicated applied research trials	8.95	2.00	4.3683	* *
E. On-farm replicated applied research trials	4.95	1.68	2.4003	*
F. On-farm production plots	3.17	2.46	0.4226	n.s.

in their work organizations. These findings, therefore, direct the inquiry to the intervening variable--the training itself--to see if the differences in training could account for the observed differences in work behavior.

[4]Note: the statistical notations used in both Tables VIII-5 and 6 are defined as follows: n.s. is not significant, * is significant at the .05 level, and ** indicates the difference is highly significant or at the .01 level.

TABLE VIII-6

Analysis of Variance of the Work Behavior of Individual Trainees Who are Only Working on Wheat/Rice Research for the CIMMYT and IRRI Research Training Groups (data reported is the mean level of each activity completed per trainee during the main wheat or rice growing season of 1972)

Type of Activity Completed	CIMMYT Wheat Trainees (N = 81)	IRRI Research Trainees (N = 82)	t values	Level of Significance
A. Laboratory and greenhouse experiments	1.72	1.12	0.5778	n.s.
B. On-station field research experiments	5.89	3.84	1.3358	n.s.
C. Genetic crosses	261.2	28.0	5.5943	* *
D. On-station replicated applied research trials	8.36	1.52	4.4190	* *
E. On-farm replicated applied research trials	4.43	1.26	2.6425	* *
F. On-farm production plots	3.77	1.99	1.1194	n.s.

Differences in Training As An Intervening Variable

The training objectives, methodology and strategy of the two research training programs being considered here are markedly different. Both training approaches have been described in detail in their respective chapters of this thesis. The purpose here is not to repeat this material, but only to summarize the key points which appear to directly link these different training approaches to

the differences in work behavior which have been observed.

The main educational objective associated with the research project approach to training that has been employed by IRRI is analysis. In following this type of program the trainee learns first hand how to design, carry out and report on a research experiment and in doing so learns how to think analytically--a prerequisite for any successful research worker. Having this ability and skill, however, does not prepare a research worker for any type of research work. In particular, he does not learn the research skills and methods associated with organizing and operating a research program aimed at developing improved agricultural technology, where the primary educational objectives are synthesis and evaluation--objectives which characterize the CIMMYT wheat training program.

As described earlier (see pages 75-89), the CIMMYT wheat research program is a highly organized "genetic assemblyline" which has standardized procedures and routinized tasks to increase the efficiency and output of a wheat improvement research program, while minimizing error. By systematically mixing (synthesis) the gene pool through large numbers of genetic crosses and by systematically screening the progeny of these crosses, particularly through the extensive use of early generation testing procedures (evaluation), CIMMYT scientists believe they can maximize the probability of producing superior germ plasm. CIMMYT wheat trainees appear to have learned and to have adopted this research approach to wheat improvement, given their observed behavior.

The conclusion of this research is that the different approaches to research training that are being pursued by IRRI and CIMMYT are having an important and measureable influence on the work behavior of research workers in less developed countries. In the one case, research workers are tending to emphasize experimental research aimed at generating new knowledge about rice production in the tropics. The other training group tends to emphasize and to be very efficient and productive in conducting research aimed at developing improved wheat technology. Next, the policy implications of these two training approaches will be considered.

Policy Implications and Recommendations

The Appropriateness of Training Strategies in Meeting Technical Manpower Requirements of Effective Agricultural Research and Extension Systems

In the first chapter of this thesis, the case was made and documented that one of the most serious problems facing research institutions in less developed countries is an inappropriate or unbalanced research orientation. The concern was expressed that research scientists, who have received their training in foreign universities, have tended to adopt the normative structure of those public research institutions that reward contributions to the body of knowledge in each field of study (i.e. knowledge generating types of research).

Many of these scientists, after returning home, are concerned with establishing a professional reputation in their field

of study. To do so, they find it necessary to focus on theoretical research problems within their field of study, rather than working on applied research problems aimed at developing new, improved crop technology for producers. And, as H. W. Singer has pointed out, frequently these theoretical research problems represent the frontiers of knowledge as defined by the scientific community of industrialized nations--research problems which are probably far removed from the problems faced by the less developed nations. Unfortunately, because of the low status of agricultural producers in most countries and because of the lack of any professional reward system to credit research activities aimed at developing improved technology, few scientists have felt inclined or obligated to give much attention to helping cultivators and peasants to increase their agricultural production.

In the discussion on research allocation in the effective agricultural research system in the United States, it was established that in the mid-sixties approximately 70% of total research expenditures (including both the public and private sectors) went for applied research activities, while only about 30% of the agricultural research budget went for fundamental research (see Table I-1 on page 20).

Another factor that points to the need for a heavy emphasis to be given to technology development types of research is the fact that most foreign agriculturists, who are assigned by the Ford and Rockefeller Foundations to national programs as working scientists, generally concentrate on research activities aimed at creating improved crop varieties or developing improved production

practices, rather than conducting experimental research aimed primarily at knowledge generation. These foundation scientists are highly trained and experienced research workers; yet, many are involved in the rather elementary task of adapting high yielding varieties to fit local growing conditions, developing fertilizer recommendations, etc.

One such scientist, whom the investigator interviewed while conducting this research, indicated that he was forced to take his breeding materials to his private house after harvest since previous experience convinced him that local researchers lacked the interest and/or training to carefully store and to properly prepare the breeding lines for planting the next season. Another scientist reported the absence of reliable data on which to base fertilizer recommendations for the improved varieties. While local research workers were available and responsible for these essential research tasks, in most cases they lacked the interest, motivation and/or training to get out on farms and to conduct the necessary replicated applied research trials on which accurate production recommendations could be based. Therefore, the majority of this scientist's time was spent conducting on-farm applied research trials.

These observations, the allocation of research expenditures in the effective agricultural research system of the United States and the discussion in the agricultural research and training literature of the problem of an unbalanced or inappropriate research orientation, all strongly support the proposition that agricultural research workers in less developed countries should give the majority of

their attention to technology development types of research.

While it is difficult to directly equate one type of research activity with another, Figures VIII-1 and 2 give a graphic comparison as to how former trainees from IRRI and CIMMYT are allocating their time to knowledge generating and technology developing types of research, as well as to technology extension activities. Next each of these figures will be discussed separately.

IRRI Research and Production Training Programs

The combined efforts of IRRI research and production trainees show a polarization of emphasis, with research workers concentrating primarily on knowledge generating research and with rice production trainees conducting substantial numbers of production/demonstration plots--which serve to extend the improved rice technology to farmers. While technology development research activities are not being neglected by former research trainees, clearly these activities are being given less emphasis than knowledge generating types of research work. This observation is reinforced by the fact that IRRI research trainees have published or presented 375 technical papers in the last two years alone (1971-72). While this is an impressive contribution to the body of knowledge about rice production in the tropics, there remains the obvious need to translate this knowledge into useable forms of improved technology--a need that is receiving inadequate attention from former IRRI research trainees.

Rice production trainees, on the other hand, have been very productive in helping farmers establish high yielding production/

Figure VIII-1: Work Behavioral Patterns of Former IRRI Research & Production Trainees

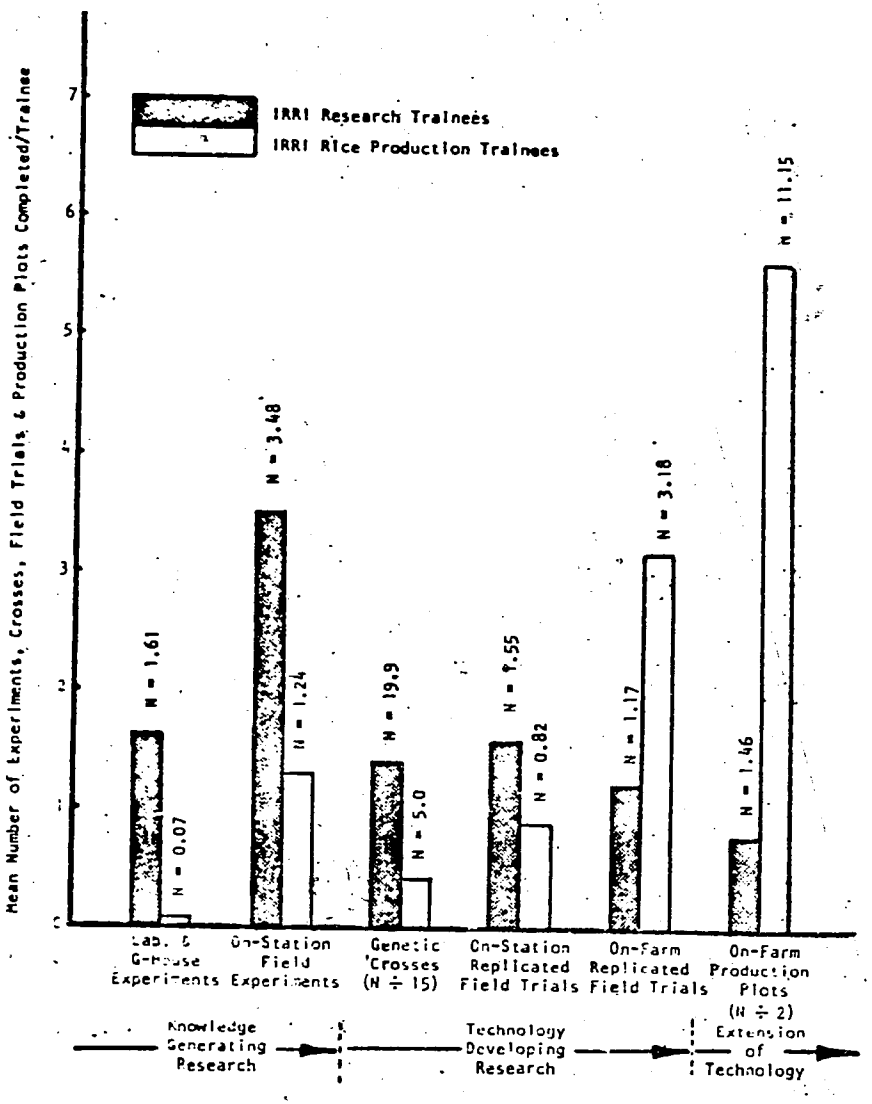
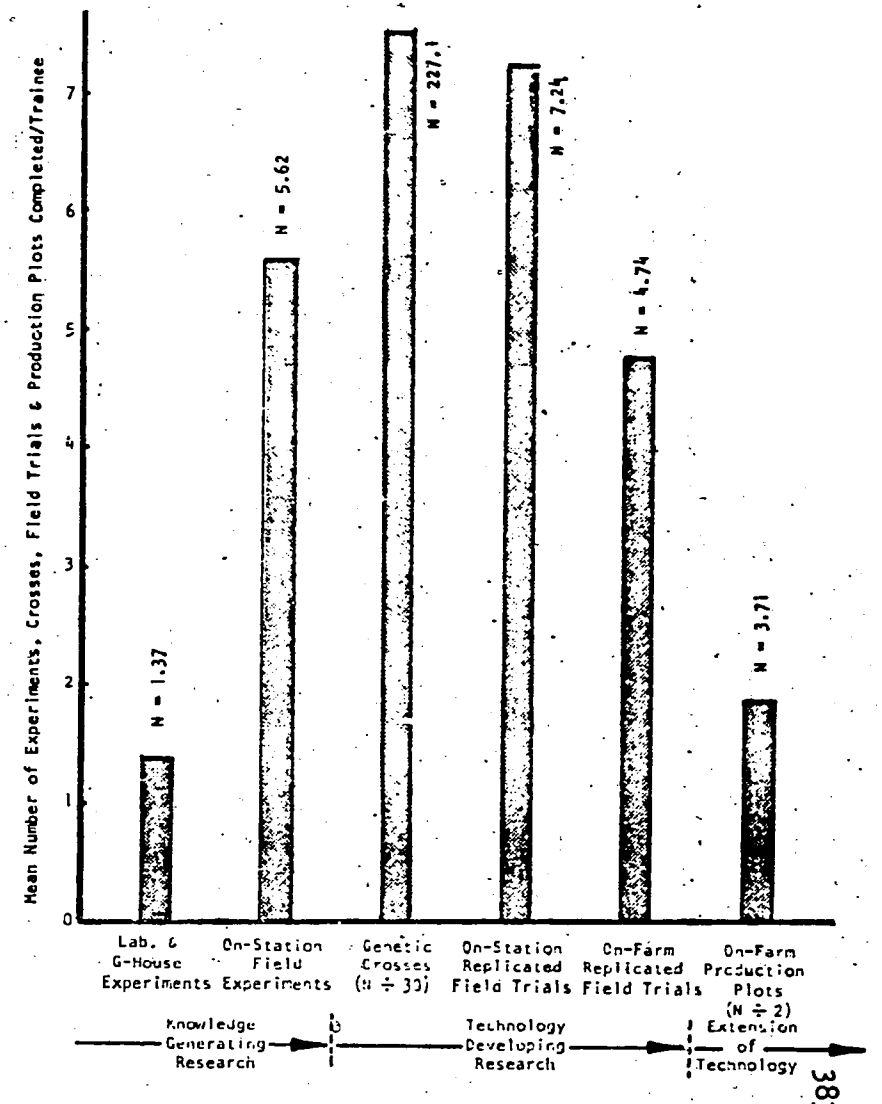


Figure VIII-2: Work Behavioral Patterns of Former CIMMYT Wheat Trainees



demonstration plots, and some trainees have been able to carry out on-farm replicated applied research trials. On the whole, however, it appears that many rice production trainees are recommending IRRI developed rice technology with a minimal amount of systematic testing and modification.

Although IRRI research trainees do focus on problems of rice production in the tropics, which is an improvement over the research focus of some of their foreign university trained colleagues (who, as Singer suggests, frequently work on research problems that are defined by the rich industrial nations); nevertheless, the majority of these trainees appear to accept or be operating within a normative structure that rewards contributions to the body of knowledge of their respective disciplines. Or as one foundation scientist, who has had extensive contact with returning IRRI research trainees, put it: "Research trainees are in a hurry to get back into their own little niche."

Based on these findings of research worker behavior and the suggested emphasis that should be given to different types of research activities, it is recommended that IRRI critically assess the technical manpower requirements of cooperating national research programs and, then, possibly consider changing its research training strategy in light of this information to better meet the overall technical manpower requirements of national research programs.

CIMMYT Wheat Training Programs

CIMMYT wheat trainees, while not neglecting knowledge generating research activities, have given major emphasis to

technology developing types of research activities; and, the balance between these two types of research activities appears to be consistent with the evidenced needs of national research programs. There is a third dimension to the problem of research emphasis which is not shown by Figure VIII-2, but which may represent an internal imbalance within the technology development function which may be characteristic of the CIMMYT wheat training group.

While there was no way to differentiate the data between types of replicated applied research trials that were reported by CIMMYT trainees, observations made by the investigator in the field suggest that the majority of attention was being given varietal field trials, rather than a full range of production field trials. As pointed out in the chapter on the CIMMYT training program, the dominant emphasis within the training program during the sixties was on developing genetic technology. While a wheat production training program was established in 1970, it has been largely patterned after the IRRI rice production training program and is primarily directed toward training extension personnel. While the wheat production program addresses a technical manpower need that requires continuing attention, CIMMYT has failed to give adequate attention to the problem of training research workers who can develop the production technology (cultural practices, fertilizer recommendations, etc.) to fully exploit the genetic potential of the improved wheat varieties--while minimizing risk to farmers. Furthermore, this technical manpower problem will become increasing limiting to national wheat improvement programs as

the improved genetic technology spreads out of the limited irrigated zones and into the more extensive rainfed areas. While CIMMYT has taken the position that these types of production research problems are location specific and must be resolved locally--which is a valid position vis-a-vis CIMMYT's own research efforts--this position does not preclude the need for production research training and CIMMYT should give careful attention to this problem.

Organizational Change As An Appropriate Training Objective

The most basic difference between the two institution building strategies included in this research concerns the assumptions made about the ability of most national research systems in less developed countries to organize their scientific resources. While this is a complex issue, each center's response to this question, provides some valuable insights into the problem.

IRRI's response to this issue was essentially that the national programs it was working with did have the ability to organize their scientific resources, but lacked an adequate supply of properly trained research workers. Therefore, it set up a research training program that was logically consistent with this working assumption. To demonstrate why this response is logically consistent, it is necessary to digress briefly and review a comparable situation.

IRRI is operating on the basis of the same type of institutional relationship that a college of agriculture (as an educational institution) would have with a functionally effective experiment station (as a work organization). The college provides graduate students with a good

theoretical background in a field of study, along with a solid research experience in designing, conducting and reporting on a research project. Once hired for a particular research position, however, the student is given specific research responsibilities (tasks) that he is expected to carry out--which are functionally integrated with the overall research program. Then, by assigning the inexperienced research worker to work with a senior scientist, the organization provides him with sufficient informal, on-the-job training until he can function independently in carrying out his assigned tasks.

The observed work behavior of former IRRI research trainees, as they return home to concentrate on knowledge generating types of research, places IRRI's operating assumption, about the ability of national research programs to organize their scientific resources, in serious question.[5]

CIMMYT's response to this question is essentially based on the premise that the national wheat improvement programs it is working with are not functioning effectively because they are unable to organize their scientific resources to solve practical production

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[5]It should be noted that several countries from which IRRI receives substantial numbers of trainees (for example: Japan, Taiwan and Korea) are assumed to have rather effective research systems at the present time. Therefore, this type of research training may be quite appropriate in meeting their needs. However, if these programs are in fact relatively strong and functioning effectively at the present time, there would appear to be little justification for IRRI to expend its scarce training resources on research personnel from these countries, when the important rice growing countries of the tropics have weak research systems.

problems. By identifying this inability as a serious institutional problem, it follows that technical personnel, in addition to lacking relevant research skills and methods, also lack the skills and spirit of working together in a cooperative team effort. More precisely they lacked the organizational skills and perspective necessary to integrate their research functions. Thus it was found that CIMMYT trainees in cereal technology would spend one-fourth of their time in the wheat breeding program, so they would clearly understand and appreciate the functional relationship between their work in cereal technology and the work in the breeding program. Likewise, each training group would spend a substantial amount of time working in each of the other respective research programs that are functionally involved in developing improved genetic technology.

In conclusion, what appears to be the case is that complex research systems which developed in the United States (and other industrialized nations) were structurally transplanted into less developed countries. Because these institutions did not develop out of actual agricultural problems found in each respective country and because these research institutions were established as structurally complex organizations, the various disciplinary departments within these national research institutions never became functionally integrated. Therefore, the resulting behavior of most research scientists was to pursue individual research projects that would enable them to advance professionally.

CIMMYT's response to this perceived institutional problem was to concentrate on one specific production problem--the need for

improved genetic technology--and through its training approach to carefully and systematically build this relatively simple research function into each national program (i.e., organizational change as a specific training objective). Once a "critical mass" of trained research workers was present and the program functioning effectively, each national program would be expected to begin: (1) working out its own research structure (i.e. division of labor) to fit local needs and requirements and (2) to take over the necessary informal on-the-job training of new personnel. Once this transition is made, the national wheat improvement program will be able to achieve those research objectives that are securely rooted in local production problems.

IRRI, by using the research project approach and by training research workers in separate disciplinary departments, accepts an organizationally complex research structure as the best way to organize scientific resources and, therefore, does not perceive it as an institutional problem--particularly not a problem to be resolved through its training programs. Therefore, while trainees return home to study relevant production problems, it appears that in most cases their research efforts lack the necessary functional integration that will result in improved rice technology being developed. Where this occurs, the national research system will remain functionally impotent in its ability to solve serious production problems and the nation will remain totally dependent on external sources for new sources of improved technology--which will have to be supplied, in large part, by the international research centers themselves.

The Need to Redirect Professional Reward Systems

The case has been made in this study that the development and delivery of improved technology to agricultural producers is essential if agricultural production is to be increased. For this to occur, a substantial portion of the national research effort will have to be redirected toward the problem of translating existing knowledge into improved technology. But what incentives are available to encourage research workers to willingly and aggressively undertake these research responsibilities? Essentially there are none.

First, salaries for most research and extension workers are low, particularly in comparison with their research counterparts at the international centers. For example, the present mean monthly salary (in U.S. dollar équivalents) for CIMMYT wheat trainees is $202.; for IRRI research trainees it is $193.; for IRRI rice production trainees it is $104. Since the entire national research system is in the public sector, it is not possible to give--as private industry does in the United States--a higher salary differential for those scientists who choose to take on technology development (R & D) assignments.

Second, in most cultures agricultural work is a low status occupation; therefore, there are no positive social sanctions (essentially only negative ones) that would encourage a highly educated scientist to go to the field and work with an illiterate peasant. And even if individual scientists were motivated to do

this type of research work, the research organization has no effective way to reward such behavior.

Finally, the spirit of cooperation is frequently missing from national research programs, and scientists tend to think in terms of achieving personal, rather than institutional credit. To develop improved technology requires considerable interdisciplinary cooperation; but, in this case, it is the team, not the individual, that must share the credit. However, if this team credit is usurped by the research director or the team leader rather than being shared by the team members, individual research workers will not be encouraged to work together. Given these conditions, it is not difficult to see why most agricultural research workers in these national programs have tended to concentrate on individual research projects (knowledge generating research) and the professional recognition that goes with publishing research papers--particularly in international scientific journals.

To provide some incentive for research workers to take up the task of developing improved technology and for extension workers to concentrate on the effective and efficient delivery of improved technology to farmers, it seems both logical and essential for the international research centers to develop appropriate systems to reward those research and extension workers who are aggressively carrying out these highly important, but currently low prestige, tasks and functions.

An example of one such reward system is the FAO follow-up workshops for former CIMMYT trained wheat and barley workers in

the Near East (see page 154). While the expressed purpose of these workshops is to bring former trainees up-to-date regarding new developments in wheat improvement, these workshops also serve the dual purpose of being an effective reward mechanism. First, by having the workshops in different countries each year (rather that at CIMMYT) it is the national wheat team that receives much of the recognition and attention. In addition, while participants receive the satisfaction of renewing old friendships, they are also able to compare their programs and progress with other national wheat improvement programs, and in doing so pick up new ideas, exchange materials, etc. Finally, since the main selection criteria for these workshops is based on the trainee's continuing direct involvement in wheat improvement work, it is the research worker's behavior, rather than some other criteria (such as position or professional reputation) that is being rewarded.

In conclusion, it is clear that international centers cannot prevent research workers from concentrating on knowledge generating research activities; but, there is much that can be done in terms of positive sanctions, as part of a systematic follow-up effort, to reward those research workers who are working hard to develop and deliver improved technology to help solve farmer production problems. In this regard, CIMMYT should expand its current activities in this area, by including all of its former trainees in these regional workshops. In addition, CIMMYT should also explore other types of reward systems--particularly for senior scientists in national programs--that would call attention to these

specific types of research achievements that are not being professionally recognized at the present time. Likewise, IRRI should give serious consideration to institutionalizing reward systems that would give former trainees and rice research workers an incentive to pursue technology development types of research work.

The Need to Carefully Evaluate The "Train the Trainer" Approach

IRRI, through its rice production training program, and more recently CIMMYT, through its wheat production training program, have focused on the "train the trainer" approach to meeting the technical training needs of national extension service personnel. The objective of this approach is to build an in-service training component within national extension programs whereby the technical knowledge and skills of field level extension personnel can be up-graded and improved. While in theory this idea has great potential, in practice there are many difficulties that can limit the success of this approach.

First, institutional conflicts between the research and extension organizations can be increased rather than lessened. For example, rice production trainees are trained in the new rice technology that IRRI has developed and are specifically taught the necessary methods to adapt this technology to local conditions. Institutionally, this approach can weaken rather than encourage a closer working relationship between the extension service and

the research institution. Interviews with rice production trainees in the field clearly indicated that these individuals continue to look to IRRI, rather than their local experiment station, for new sources of improved production technology.

Second, some trainees may conduct training programs but be unable to actually create the desired multiplier effect because of organizational restrictions. For example, some respondents reported training rather significant numbers of farmers since returning home, but in this case there was no multiplier effect within the extension organization itself. The trainee was only using organized training programs as a means of extending the improved technology to farmers, rather than working with farmers through the use of high yielding production/demonstration plots or minikits,[6] which are more commonly used by the production specialists trained at IRRI.

Another serious problem that can limit the usefulness of the train the trainer programs and the hoped for multiplier effect, is what might be called the "dilution effect". Most training programs that were reported by IRRI rice production trainees varied from one day to about two weeks in length. The amount of technical information and the number of production skills which can be imparted to field level extension workers in a short period of time is largely dependent on the training methodology, techniques

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[6] A minikit is "A package of applied research materials containing at least 6 rice selections and varieties with measured amounts of fertilizer, insecticides (and herbicides) designed for the farmer to be planted in 300 sq. m." (Castro, 1972, p. 71).

used and the capability of the participants. IRRI's approach to this problem, which their trainees are encouraged to utilize, has been to use staggered plantings of rice, so that within a one or two week training period trainees can obtain direct field experience in all of the production skills associated with growing a rice crop and in using the improved technology.

While using staggered plantings of rice is an effective training technique, this approach requires careful planning, good organizational skills, as well as sufficient land, equipment and supplies. In a study of former rice production trainees in India, Donald Green found that while the majority of returnees had been directly involved in rice production training programs in their home states, only one group had yet been able to organize its short term training sessions around this key "learning by doing" training technique (Green, 1970, p. 12). Green goes on to point out the shortcomings of training programs that are geared to classroom instruction and demonstration, rather than concentrating on indepth skill training in growing a rice crop using improved production technology:

> The key to the 'learning by doing' approach is the identification of and provision for practice in doing the specific skill required. Growing rice involves a series of interrelated and complementary operations throughout the crop cycle. Poor performance, deletion, or untimely application of one or more of these operations can seriously affect yield and returns, especially with the new varieties which have a substantially different plant environment. In addition, the ability to diagnose problems and apply correct solutions before the consequences become too serious requires high levels of skill and understanding. Training activities which

> rely primarily on imparting knowledge by lecturers, information giving and poorly designed and conducted practicals are of questionable adequacy for a modernizing agriculture (Green, 1970, p. 7).

Finally the fact that so few rice production trainees have been able to function as rice production trainers (12.9%) since returning home suggests that this approach has not been very successful in achieving its behavioral objectives.

An alternative approach to training the trainers of crop production specialists would be to concentrate on an on-the-job or non-formal training system for research and extension workers who are directly involved in production programs--rather than attempting to establish formalized in-service training centers as is required with the present approach. While this alternative approach is beyond the scope of this study, IRRI's Upland Rice Project and CIMMYT's Puebla Project appear to offer considerable potential as national training models for production research and extension workers.

Once such functionally effective production research-extension projects are established in a country (as IRRI has done in the provinces of Bulacan and Nueva Ecija and as CIMMYT did for maize in the state of Puebla), these on-going production programs could be used to train new teams of research and extension workers both for other regions within the same country and for new regional projects in other countries. This approach could produce the desired multiplier effect, while avoiding many of the potential problems and weaknesses of the current "train the trainer" approach.

In conclusion, it seems clear that there are many unanswered questions regarding how best to train production research workers and production extension specialists. Also, there is the problem of training village level extension workers. The "train the trainer" approach that is currently being pursued by both centers appears to have many serious limitations. To adequately determine the effectiveness of this approach, however, will require a close examination of the second generation training programs that have resulted and their direct influence in improving the work performance of field level extension workers. At the same time, however, it is recommended that both centers carefully explore the potential of using regional production projects as a means for training integrated production research-extension teams as has already been done quite successfully in the Puebla Project.[7]

Conclusion

The Need For An Integrated Institution Building Approach To Training

This research has stressed the need for functionally integrated national research, development and extension systems. To build systems that will be effective in solving farmer production problems and in increasing food production will require

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[7]This observation is based on conversations the investigator has had with Heliodoro Diaz who has been directly involved with the Puebla Project since its inception in 1967 and who is currently completing his doctoral thesis on this project, which includes a section on training production research and extension workers.

an integrated training approach. Traditionally training has been viewed as a means of up-grading the knowledge and skills of individuals. This perspective is appropriate when dealing with productive, on-going institutions that use training to prepare new personnel for existing jobs or when training existing personnel for new assignments.

Where existing national research and extension institutions are ineffective, then an institution building approach is needed so that: (1) all essential tasks and functions needed in an effective research, development and extension system are clearly identified, (2) that appropriate organizational personnel are systematically selected for training, so they will be available in the national program when needed, (3) that appropriate types of training be provided for each trainee that focus on the specific tasks he will be expected to carry out after returning home and (4) that a team approach to training be followed, so that each member of a national crop improvement team is fully acquainted and, in so far as possible, experienced in the other functional areas of the research and extension system.

To establish training priorities, each national crop improvement program that an international center is working with should first be carefully evaluated to determine where functional weaknesses presently exist. In terms of the overall research function, attention should first be given to the processes associated with the development of improved genetic and production technology. Without this research capability, any knowledge that is generated--regardless how production oriented--must be considered as

knowledge for its own sake. At the same time when research training priorities are being considered, attention should also be given to building the technical manpower and institutional components of the delivery system that can effectively and efficiently make available improved technology (from both internal and external sources) to agricultural producers.

In addition to identifying the technical manpower deficiencies throughout the research-extension system (horizontal integration), concern should also be given to training needs at different levels within the national program (vertical integration). Based on conversations the investigator had with different international research center officials, there appears to be a trend at some centers to direct their research training to more highly educated research workers within national programs, rather than developing organized training programs for younger, middle-level research technicians. This approach appears to be based on unsupported assumptions and is an approach open to serious question. For example, one official said that their goal was to train research leaders. The conclusion reached in this research study suggests that effective research institutions cannot be built by only training research leaders, nor can they be built from the top downward. Highly trained scientists, without having the essential supporting staff of competent middle-level technicians, will be inefficient, if not ineffective. The question is, who will train these younger middle-level technicians if the international centers decide not to direct a substantial part of their training resources to this manpower development problem?

Furthermore, by the time research workers reach the Ph.D. level, their professional values and attitudes may be firmly molded and there may be little a research training program can do at this point in their professional development to redirect their research orientation. Given the high cost of training and educational programs, it may be more expedient for the international centers and fellowship granting agencies to work more closely together and use the short term, practical research and production training programs (such as IRRI's rice production training program and CIMMYT's wheat training programs) as a means of building a solid core of competent middle-level research and extension workers and at the same time use these programs as a selection tool for the more expensive educational degree programs (see pages 136-39). By following this approach, international research centers, foundations and other development agencies could work together in up-grading technical personnel at all levels within the overall research-extension system and thereby help mold the development of research workers and their respective institutions around the critical problem areas faced by farmers in each country.

In conclusion it should be pointed out that implicit in this discussion of an institution building approach is the obvious need for extensive and continuing communication between the individual national programs and the international centers. To be effective in meeting the real manpower and institutional needs of national programs, the international center must work in close cooperation with the leadership of each national program. To do this, the

training institution (international center) needs continuing feedback from the work organization (national program) and from former trainees. Only by working in close cooperation with each national program can training needs be systematically identified and resolved.

APPENDIX 1

SUMMARY OF RESEARCH METHODOLOGY

Data collection for this study required about one year to complete. During this period, three distinct stages in the data collection process were followed: (1) collecting descriptive information on the respective training programs--which served as the basis for designing the data collection instrument, (2) pre-testing the survey questionnaire with former participants in two national programs and (3) conducting the international mail survey of all former trainees that had participated in one of the three training programs to be included in this study.

The first two stages of the data collection process were completed during the fall of 1972. After reviewing the previous research of other training programs and after studying the training materials that were available from both IRRI and CIMMYT, a draft questionnaire was developed. The investigator then traveled to Mexico and spent two weeks reviewing training objectives and procedures of the wheat training program with CIMMYT officials. Each wheat scientist and the training officer was interviewed to obtain first hand a composite representation of the educational objectives, methodology and philosophy behind the wheat training program. In addition, the draft questionnaire was discussed with each staff member and the names and addresses of former

in-service trainees was obtained.

Data collection on the IRRI training programs began at the Centro Internacional de Agricultura Tropical in Cali, Colombia where the investigator reviewed the development of the rice research and rice production training programs with Dr. Colin McClung, who was the former Associate Director of IRRI and, in this capacity, was directly responsible for the research training and international outreach programs; and with Dr. Francis Byrnes, who was the former director of Communication at IRRI and who played an instrumental role in the development of the rice training program.

Next, the investigator spent three weeks at IRRI headquarters in the Philippines during which time he reviewed the training objectives and procedures of the two rice training programs with appropriate IRRI officials. Again the procedure was to interview all of the scientists and staff members that were directly involved with each of the two training programs, to obtain a composite representation of the objectives, methodology and philosophy behind each training approach. Again, the draft questionnaire was discussed with staff members and the names and addresses of all former research and rice production trainees was obtained. After completing the data collection on the two IRRI training programs, the training questionnaire was finalized and reproduced for the pre-test before leaving IRRI headquarters.

The next four weeks were spent in Sri Lanka and Pakistan where the questionnaire was pre-tested with approximately 60

former trainees. Since it was important to include the data from these pre-test respondents in the study, yet it was essential not to bias the respondents, the following procedure was used: First, the trainee was briefly told the purpose of the study (the same information that was included in the covering letter for the mail survey), second that the results would only be used in statistical analyses, and third that all responses would be kept confidential and anonymous. Next, the respondent was asked to complete the questionnaire in the same manner as if he had just received it in the mail. After the questionnaire had been completed, the respondent was then interviewed in detail about his present job assignment. Finally the questionnaire was reviewed with the respondent to determine if he had misunderstood any of the questions, or if any of the questionnaire data was inconsistent with what had been learned during the interview. By following this procedure, it was possible to both pre-test the questionnaire, while obtaining reliable information that could be used in the study itself.

After pre-testing the questionnaire in the field, the data collection instrument was finalized and reproduced in Madison. The international mail survey was launched in mid-February, 1973. The materials used in the mail survey are attached as part of this appendix, however, the following steps were followed: The initial questionnaire packet, which was sent to all appropriate trainees included 5 items: (1) a covering letter from the respective director of each international center and the investigator which outlined the purpose of the research, (2) the questionnaire itself, (3) a self

addressed return envelope, (4) four international reply coupons and (5) and information form to determine if the trainee was still on the institute's mail list.

Since this was an international survey and, therefore, impossible to provide stamped, self-addressed envelopes for all respondents, international reply coupons were used in the majority of the cases. In some cases, however other procedures were used. In the case of the CIMMYT trainees, about half of the questionnaire packets had been sent before the investigator learned of the existence of the international reply coupons. It appears that much of the difference in response rates between the IRRI and CIMMYT groups can be explained by the fact that these reply coupons were not used for many of the CIMMYT trainees. The procedure used in countries where IRRI and CIMMYT had local representatives, was to send all of the questionnaire packets to this representative, so that he could double check trainee addresses and to place stamps on the reply envelope, before mailing the questionnaires directly to the respondents.

After the initial questionnaire packets were sent out, two follow-up procedures were used. Approximately three weeks after mailing the questionnaires the first follow-up letter was mailed to all participants. The purpose of this letter was to thank those participants that had already returned the questionnaire and to remind those that had not returned it, to do so as soon as possible. Then, about 6 weeks later a final follow-up letter was sent to all trainees that had not returned a completed questionnaire. Enclosed with this second follow-up letter was a postcard that the trainee

could return to the respective center if he had (1) already returned the questionnaire, and in this case he was asked to indicate how long ago he had returned it; or (2) if he had never received the questionnaire, to indicate this fact and to return the card, so a second questionnaire could be sent. If the trainee still had the questionnaire, he was requested to complete and return it as soon as possible to the respective center.

As questionnaires were received by CIMMYT and IRRI, they were forwarded to the investigator in Madison about every two weeks for coding. The final cut off date for inclusion in the Study was September 1, 1973, therefore, any questionnaires that were received after this data were recorded, but not actually included in the analysis. Copies of the different research materials used in the study follow. It should be noted that in total, 4 different questionnaires were used in this study. They were: (1) CIMMYT Questionnaire in English, (2) CIMMYT Questionnaire in Spanish, (3) Rice Production Questionnaire and (4) Rice Research Questionnaire. The only substantive difference between the rice research questionnaire and the other three questionnaires was page 3, which included several different questions.

INTERNATIONAL MAIZE AND WHEAT IMPROVEMENT CENTER

TRAINING QUESTIONNAIRE

INSTRUCTIONS:

The following questionnaire should take you about one hour to complete. Please answer all questions as completely and as accurately as possible. For those questions requiring you to check only the appropriate box, please note that in all cases the boxes are at the right hand side of the answer category. Please check the appropriate box by placing an "X" in the center of the box as follows: [X]. For questions requiring a written answer, please print. Thank you.

- -

APPLICATION AND SELECTION PROCESS:

(The following questions refer to the period from when you first applied or learned you were being considered for the CIMMYT training program, until your actual departure for the training program.)

1. What types of information did you receive about the training program before your departure--from any source? (check all that apply)

   (a) Specific objectives of your technical training program..... ☐

   (b) Outline of the proposed plan for your technical training..... ☐

   (c) CIMMYT administrative policies and regulations for trainees..... ☐

   (d) Relationship of the objectives of your technical training program to the wheat research and production program in your home country..... ☐

   (e) Information about Mexico..... ☐

   (f) Did NOT receive any information before departure..... ☐

2. Generally, how adequate was your information about your proposed training before you left your home country? (check one)

   very adequate.. ☐ somewhat adequate.. ☐ somewhat inadequate.. ☐ very inadequate.. ☐ don't remember.. ☐

3. At the time you left for the training program at CIMMYT, how much did your supervisor know about the proposed training? (check one)

   he knew a great deal.. ☐ he had some information.. ☐ he knew little or nothing..... ☐ don't know or don't remember.. ☐

4. Of all the sources of information you had before leaving for the training program, which person or agency do you feel was most helpful in preparing you for the training? (If a person, do not give his name but his position or relationship to you. For example: a former trainee, your supervisor, a CIMMYT official, etc. or the training brochure.)

   _____

5. What type of organization were you working with at the time you were selected for the training program at CIMMYT? (check one)

   government research organization.. ☐ government extension service.... ☐ agricultural college or university.. ☐ company business or industry... ☐ unemployed.. ☐ or student.. ☐ (Go to No. 10 on page 2.)

   other.. ☐ (specify): _____

6. How long had you been working for this organization before being selected for the training program at CIMMYT?

_____ years

7. What type of position did you hold at the time you were selected for the CIMMYT training program? (check one)

mainly administrative work..... ☐ mainly field research.. ☐ mainly lab. or greenhouse research..... ☐ mainly field extension work..... ☐ mainly teaching or training.... ☐

8. What type of crop research or extension program were you working with before coming to CIMMYT? (check one)

only working with wheat.... ☐ working with wheat and other crops..... ☐ was not working directly with wheat before coming.. ☐

9. Selection criteria for training and educational opportunities differ between countries and programs. Listed below are factors that are sometimes important in selecting trainees. To what extent do you think each of these factors was important in your selection for the CIMMYT training program?

Factors:	very important	somewhat important	not important	don't know
(a) Seniority--next in line for training.....	☐	☐	☐	☐
(b) Educational qualifications.....	☐	☐	☐	☐
(c) Needed the training to do my job more effectively.....	☐	☐	☐	☐
(d) I had good relations with higher officials in my organization.....	☐	☐	☐	☐
(e) I had good relations with the local CIMMYT representative.....	☐	☐	☐	☐
(f) Language ability (English).....	☐	☐	☐	☐
(g) Member of an accelerated wheat improvement program in home country..	☐	☐	☐	☐

TRAINING AT CIMMYT:

10. In which CIMMYT training program did you participate? (check one)

wheat breeding.. ☐ wheat production.. ☐ cereal technology.. ☐ pathology.. ☐

11. How many months in length was your training at CIMMYT?

_____ months

12. In what year did you complete your training at CIMMYT?

19-_____

REACTION TO THE TRAINING AT CIMMYT:

CIMMYT trainees have reacted differently to the training situation. Listed below are some aspects of the training program which we would like to have you consider. Please select the answer for each condition which best describes your feelings about the training: (check one for each condition)

13. Considering your previous background and experience, would you say that the level of the training program was:
   - much too elementary?.. ☐
   - a little too elementary?.. ☐
   - about right for me?..... ☐
   - a little too difficult?... ☐
   - much too difficult?.. ☐

14. Did you feel the amount of supervision and direction given by the senior staff was:
   - very adequate?.. ☐
   - somewhat adequate?.. ☐
   - somewhat inadequate?.. ☐
   - very inadequate?.. ☐
   - don't remember.. ☐

15. In regard to the job to which you expected to return, were the technical skills and research techniques learned:
   - very appropriate?.. ☐
   - somewhat appropriate?.. ☐
   - somewhat inappropriate.. ☐
   - very inappropriate?.. ☐
   - don't remember.. ☐

16. How would you rate the amount of field practice time allowed to learn wheat research and/or production skills?
   - enough time to master the skills.. ☐
   - enough time to learn the skills.. ☐
   - enough time to become familiar with the skills.. ☐

17. How was the balance between theoretical instruction and practical training?
   - much too theoretical.. ☐
   - a little too theoretical.. ☐
   - balance was about right.. ☐
   - a little too practical.... ☐
   - much too practical.. ☐

18a. Which aspect of the total training experience at CIMMYT did you feel most satisfied with?

_____

18b. Which aspect of the training experience at CIMMYT did you feel least satisfied with?

_____

18c. Explain briefly why you feel this way: _____

_____

USE OF YOUR TRAINING AFTER RETURNING TO HOME COUNTRY:

(The following questions ask about the use of your training in the job to which you returned the first year following the training program.)

19. Did you return to the job that you had expected before your departure?
   - yes.. ☐
   - no.. ☐
   - didn't have a job before going to CIMMYT.. ☐ (Go to No. 22)

20. To what extent was this the same job or a different job than you had before the training program at CIMMYT?
   - same job.. ☐
   - somewhat different job.. ☐
   - very different job.. ☐

21. Were you given increased job responsibilities as a result of the training you received at CIMMYT?
   - no.. ☐ ↓
   - yes.. ☐ If yes, was the change in your job responsibilities planned before you left your home country for the training?
     - no.. ☐
     - yes.. ☐
     - don't know.. ☐

22. How much of the training you received at CIMMYT were you able to use during the first year on the job, after returning home?

little or no use of training..☐ | some use of training.....☐ | full use of training.....☐

23. Describe one or more new technical skills, research techniques or methods that you learned during your technical training that you have used in your home country program:

_____

_____

_____

24. Have you had the opportunity to train other research or extension personnel in specific work skills (that you learned at CIMMYT) since returning home?

no..☐ | yes..☐ If yes, then answer the following:

25. Since returning home, have you worked in or directed an organized training program for research and/or extension workers in your national program?

no..☐ | yes..☐ If yes, what was the average length of a training program; and the total number trained?

average length:____weeks; total no. trained:_____trainees

26. Have you trained other research or extension personnel--that you work with--in more informal, on-the-job situations?

no..☐ | yes..☐ If yes, how many persons would you estimate you have helped train in this way?

Estimated number trained:_____

27. The following are a list of factors which may have limited the use of your training after returning home. Indicate the extent to which each of the following difficulties have been a problem for you.

	not a problem for me	somewhat of a problem for me	a serious problem for me	not applicable for me
(a) Lack of laboratory or greenhouse facilities and equipment.....	☐	☐	☐	☐
(b) Lack of adequate experimental land, field plot equipment, machinery, etc.....	☐	☐	☐	☐
(c) Lack of adequate maintenance of equipment and facilities.....	☐	☐	☐	☐
(d) Lack of essential operating supplies and materials (for example: chemicals, pesticides, fertilizer, fuel, bags, etc.)..	☐	☐	☐	☐
(e) Lack of adequate budget.....	☐	☐	☐	☐
(f) Lack of adequate transport.....	☐	☐	☐	☐
(g) Lack of support from higher officials in the department or organization.....	☐	☐	☐	☐

27. (cont.)

	not a problem for me	somewhat of a problem for me	a serious problem for me	not applicable for me
(h) Lack of support and help from your immediate supervisor.....	☐	☐	☐	☐
(i) Colleagues were not interested in changing ways of doing things.....	☐	☐	☐	☐
(j) The people who work under you are inadequately trained.....	☐	☐	☐	☐
(k) Lacked authority to incorporate the new techniques and methods into your wheat research and/or production program.....	☐	☐	☐	☐

28. Did you use laboratory/greenhouse instruments and equipment OR experimental field equipment as part of the technical training you received at CIMMYT?

no..☐ | yes..☐ If yes, then answer the following:

29. Were most of the essential instruments and equipment, that you needed for your job: available when you returned home, did they become available since returning home, or are they still not available? (check one)

were available when I returned..☐ | have become available since returning..☐ | still not available..☐

30. Generally, how satisfied were you with the job assignment to which you returned after completing your training at CIMMYT?

very satisfied..☐ | somewhat satisfied..☐ | somewhat dissatisfied..☐ | very dissatisfied..☐ | didn't have a job when I returned..☐

OVERALL EVALUATION OF YOUR TRAINING AT CIMMYT:

31. In looking back, how appropriate was your technical training, considering your previous training and experience?

very appropriate..☐ | somewhat appropriate..☐ | undecided..☐ | somewhat inappropriate..☐ | very inappropriate..☐

32. In looking back, how appropriate was your technical training, considering your home country conditions?

very appropriate..☐ | somewhat appropriate..☐ | undecided..☐ | somewhat inappropriate..☐ | very inappropriate..☐

33. In looking back, how helpful has the technical training program at CIMMYT been in furthering your personal career plans?

very helpful..☐ | somewhat helpful..☐ | little or no difference...☐ | somewhat unhelpful..☐ | very unhelpful..☐

34. In looking back, how satisfied were you with the administrative support (for example: living accommodations, allowances, transportation and other services) you received from CIMMYT during all phases of your training program?

very satisfied..☐ | somewhat satisfied..☐ | neutral..☐ | somewhat dissatisfied..☐ | very dissatisfied..☐

35. Considering all of the above factors, how satisfied were you with the OVERALL TECHNICAL TRAINING you received at CIMMYT?

very satisfied..☐ | somewhat satisfied..☐ | neutral..☐ | somewhat dissatisfied..☐ | very dissatisfied..☐

36. In looking back at your training at CIMMYT, to what extent do you think this experience made a difference in your ability to help solve the agricultural problems of your country?

made little or no difference..☐ | made some difference..☐ | made an important difference.....☐

(Go to No. 38) ↓

37. If you feel the CIMMYT training program made you more effective, explain briefly why you feel this way:

_____

_____

_____

_____

FOLLOW-UP SUPPORT FROM CIMMYT:

38. Have you written or received any letters from CIMMYT scientists or officials since returning to your home country? (do not count newsletters or this questionnaire)

no..☐ ↓ | yes..☐ If yes, then answer the following:

(a) Approximately how many letters have you written to CIMMYT?_____letters

(b) Approximately how many letters have you received from CIMMYT?_____letters

39. Has a scientist or official from CIMMYT headquarters visited your station or office since you returned to your home country?

no..☐ ↓ | yes..☐ If yes, please give the approximate number of visits during which you had an opportunity to discuss your wheat program, problems and progress with him.

Approximate number of visits:_____

40. Is there a foreign wheat improvement specialist (CIMMYT, Ford or Rockefeller Foundation, FAO, USAID, etc.) in your country that coordinates CIMMYT's research and training activities with your government's wheat research and extension programs?

no..☐ ↓ | yes..☐ If yes, approximately how many visits did he make to your station or office during the past year (1972):

Approximate number of visits in 1972:_____

41. Are you currently on CIMMYT's mailing list to receive newsletters, research reports and other publications?

no..☐ yes..☐ don't know..☐

42. Has the wheat research program at your local experiment station received any International Cooperative Trials or Nurseries from CIMMYT during the past 2 years (1971-72)?

no..☐ yes..☐ don't know..☐

43. Have you attended any international workshops, meetings or conferences that were organized by or held in cooperation with CIMMYT?

no..☐ | yes..☐ How many workshops, meetings or conferences attended? _____

ADDITIONAL SUPPORT DESIRED:

Note: CIMMYT does not have the human, physical or financial resources to respond to a large number of requests for technical assistance; but CIMMYT does want to learn which types of support returned trainees would find most useful in their work.

44. Is there any factor that is limiting your wheat research and/or production work at the present time with which CIMMYT might be able to help you? (If you have no problems, or if you are NOT working with wheat at the present time, you should answer NO.)

no.. ☐ (Go to No. 45)

yes.. ☐ If yes, please read through the following types of support that CIMMYT might provide and then RANK those types of support you feel would be most useful to you. Please rank in order of usefulness, indicating the most useful item with # 1, the second most useful item as # 2, etc. (If any items would be of little or no use to you, please leave these items blank).

RANK

(a) Technical visit by an appropriate CIMMYT scientist to work with me on a specific problem..... ____

Specify problem: _____

_____

(b) Arrange for a specific piece of laboratory or field equipment that is not available in your home country..... ____

Specify item needed: _____

(c) Arrange for publications and research papers dealing with wheat research and production problems to be made available at your local library or office..... ____

(d) Arrange for a conference or workshop on a particular wheat research or production problem..... ____

Please specify the topic or problem area you would find most useful, if such a meeting were held:

_____

(e) Send or exchange genetic materials with my wheat improvement program..... ____

(f) Arrange an orientation tour to CIMMYT for my supervisor and/or higher officials in my organization..... ____

(g) Arrange for training my fellow research or extension workers..... ____

(h) Establish and send International Cooperative Trials and Nurseries that can be used at my local experiment station..... ____

(i) CIMMYT should keep in closer contact with former trainees, informing them of new developments in wheat research..... ____

(j) Help former CIMMYT trainees to keep in touch with each other, and to help them exchange ideas and materials..... ____

(k) Other (specify): _____

_____... ____

PRESENT JOB ASSIGNMENT:

45. What is your present job assignment? (Give the descriptive title, for example: wheat breeder, extension administrator, fertilizer salesman, wheat extension specialist, experiment station manager, etc. -- Note: if a student or presently unemployed, write that title or designation and proceed to question No. 56)

_____

46. How would you classify the level of your job or position in your organization?
policy-level..☐ senior-level..☐ middle-level..☐ lower-level..☐

47. What type of organization do you work for now?
government research organization..☐ government extension service...☐ agricultural college or university..☐ company business or industry....☐ other..☐ (specify) _____

48. What type of position do you hold at the present time? (check one)
mainly administrative work.....☐ mainly field research..☐ mainly lab. or greenhouse research.....☐ mainly field extension work.....☐ mainly teaching or training....☐

49. Is this the same organization that you worked for before coming to CIMMYT?
no..☐ yes..☐ not working before coming to CIMMYT....☐

50. How satisfied are you with your present job assignment?
very satisfied..☐ somewhat satisfied..☐ undecided..☐ somewhat dissatisfied..☐ very dissatisfied..☐

51. How much of the training you received at CIMMYT are you able to use in your present job?
little or no use of training..☐ some use of training..☐ full use of training..☐

52. What crop or crops do you work with most? (if more than two, name the two most important)
1st._____ 2nd._____ do not work with crops..☐

53. Do you work on wheat research and/or production problems in your present job?

no..☐ (Go to No. 56) ↓

yes..☐ If yes, please give the following information:

54. During the last main wheat growing season, please indicate the approximate percentage of time you spent working at each of the following locations or duties: (for those items not applicable, please leave blank)

(a) Greenhouse and/or laboratory work..... ____%

(b) On station experimental field work..... ____%

(c) On farm experimental field work..... ____%

(d) On farm field demonstration work, field trips, visiting and advising farmers..... ____%

(e) Extension meetings, field days, radio shows, etc..... ____%

(f) Teaching and/or training (including preparation time)..... ____%

(g) Administrative duties, writing reports, reading and writing professional papers..... ____%

(h) Other (specify)_____.. ____%

total..... 100 %

(continue to No. 55)

55. If applicable, please indicate the number of research projects, applied research trials, demonstration plots, etc. that you directly worked on and helped complete during the last main wheat growing season:

	No. Completed
(a) On station field research experiments.....	____
(b) On station replicated applied research trials.....	____
(c) Varietal improvement (indicate approx. No. of crosses made)..	____
(d) On farm replicated applied research trials.....	____
(e) Demonstration or High Yielding Production Plots.....	____
(f) Laboratory and greenhouse experiments.....	____
(g) Routine laboratory/greenhouse screening or testing work (eg. quality tests, disease screening, etc.-check if applicable)... (Go to No. 57)	☐

56. IF YOU ARE NOT WORKING IN WHEAT RESEARCH and/or PRODUCTION at the present time, please indicate how many months or years you worked with a wheat program--after you returned from CIMMYT--before you left these duties; AND the major reason for leaving this work (for example: promotion, salary increase, routine transfer, etc.)

(a) Period of time you worked with the wheat program after returning from CIMMYT:..... _____ years _____ months

(b) Major reason for changing jobs: _____

57. During the last year did you talk, meet or work with any farmers in your region?

no..☐ yes..☐ If yes, then give the following information:

58. On the average, what was the frequency of contact during the last main growing season? (check one)

several times per week.....☐ several times per month.....☐ several times per season.....☐

59. Where did your contact with farmers mainly occur? (check one)

mainly on the exp. station...☐ mainly on their farms..☐ mainly at your office..☐ mainly at meetings...☐

other..☐ Specify other: _____

60. What types of contact did you have with farmers during the past year? (check ALL that apply)

(a) advising individual farmers on improved practices..... ☐

(b) working with farmers by conducting demonstrations and/or experimental field trials on their farms..... ☐

(c) conducting field days and/or training programs for farmers... ☐

(d) organizing village or community meetings to advise groups of farmers on improved practices..... ☐

(e) Making radio reports, writing news reports, etc. for farmers. ☐

(f) Other (specify): _____

_____.. ☐

61. During the past two years (1971-72) have you written any professional or technical papers for publication, presentation, use by the national program, etc.?

no..☐ | yes..☐ If yes, how many and what types of technical papers have you prepared during this period?

No. Prepared

(a) Technical papers (for presentation or publication)..... ____
(b) Technical reports (for internal use by national program)..... ____
(c) Extension bulletins, etc. (for use by farmers)..... ____
(d) Teaching materials, training manuals, etc..... ____
(e) Other (specify):_____.. ____

BACKGROUND AND BIOGRAPHICAL DATA:

62. What is your present age? _____years; 63. Sex: male..☐ female..☐

64. What was your age when you entered the CIMMYT training program? _____years.

65. Country of citizenship: _____

66. Country in which presently employed (if different):_____

67. What was the name of the highest degree, certificate, or diploma you earned before beginning the CIMMYT training program?

Name of degree, certificate or diploma: _____

Institution & Country where received:_____

68. Have you completed or are you presently working toward a higher degree, since your training at CIMMYT?

no..☐ | yes..☐ If yes, then give the following information:

(a) Name of degree expected or received: _____

(b) Name of Institution & Country: _____

(c) Year received/expected: 19-_____; (d) Field of study:_____

69. Would you describe the place where you lived most of the time before you were 12 years of age as rural or urban?

rural..☐ urban..☐

70. What is (or was) your father's occupation or profession?_____

71. When you were growing up, did your family receive more than half of its income from agricultural sources?

no..☐ | yes..☐ If yes, then what was the primary source of that agricultural income? (check one)

(a) Family owned land that was rented or share-cropped..... ☐

(b) Family owned and cultivated agricultural land..... ☐

(c) Family cultivated land that was rented or share-cropped from someone else..... ☐

(d) Family members worked as agricultural laborers & workers..... ☐

(e) Other (specify):_____.. ☐

72. What is your regular monthly income or salary from your present job (in the currency of your home country)?

Salary/month: _____; Name of currency: _____

73. Did you receive a salary increase and/or promotion as a direct result of your training at CIMMYT?

no..☐ ↓ | yes..☐ If yes, indicate whether you received a salary increase, promotion or both:

salary increase..☐ promotion..☐ both salary increase and a promotion.....☐

74. Considering your present educational background, work experience and career interests, please indicate the type of organization you would like to be working for; and the type of work you would like to be doing TEN YEARS from now:

(a) Organizational Preference: (check only one)

government research organization..☐ government extension service...☐ agricultural college or university..☐ company business or industry....☐ other..☐ (specify) _____

(b) Job Preference: (check only one)

administrative position in agriculture..☐ extension/ demonstration work on farms..☐ fundamental or basic research..☐ applied or adaptive research..☐ teaching or training..☐

other..___ (specify): _____

Thank you for completing this questionnaire. Your help in this effort will assist CIMMYT in improving its training activities in the future. While we have tried to include questions on all factors which might have affected your training program and the use of that training once back home on-the-job, perhaps we have overlooked something that you feel is important. We suggest that you use the space below to give us your recommendations, ideas, suggestions, criticisms or comments of any kind that you feel would help us improve our training programs. Again thanks for your help.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(if this isn't enough space, please continue on the back)

APPENDIX 2.

THE EVOLUTION OF THE IRRI RICE PRODUCTION TRAINING PROGRAM

Vernon E. Ross
Rice Production Specialist

Since June 1964 IRRI has operated a rice production training program to train rice extension personnel in the science and skills of producing rice. This paper attempts to explore why the program was initiated, the salient features of the program, and how the program has evolved.

At the start of the IRRI research program in 1962, farmers in tropical Asia were using essentially the same technology in producing rice that they had been using for centuries before. Rice yields in the tropics averaged only 1,500 kg/ha as compared with over 5,000 kg/ha in many of the rice producing countries of the temperate zone. The need to find ways to improving rice yields in the tropics led to the establishment of the International Rice Research Institute in 1960.

The first attempts by IRRI scientists to achieve higher yields by employing intensive management practices on the tall, leafy tropical rice varieties failed. Dr. Sterling Wortman in the October Meetings of 1969 reported that when these varieties were fertilized during the 1962 monsoon season they lodged even before flowering and scientists got much lower yields than neighboring farmers who used no fertilizer.

This experience, however, served to highlight the need for varieties that would respond to intensive management. IRRI scientists soon were able to describe the type of rice plant that needed to be developed - short, stiff-strawed, non-lodging, responsive to nitrogen, early maturing, non-photoperiod sensitive, and resistant to diseases and insects. Thus the hunt was on for dwarfing materials from which such a rice plant could be fashioned.

Paper presented at the Annual Rice Research Conference at the International Rice Research Institute, Los Banos, Laguna, Philippines, April 19-23, 1971.

What happened is history. On the suggestion of Dr. T. T. Chang, IRRI's geneticist, three dwarf varieties from Taiwan, Dee-geo-woo-gen, I-geo-tse, and Taichung Native 1, were brought to IRRI. These dwarf indicas were to become the parents of IRRI's leading varieties. By early 1964 the Taiwanese varieties and the early crosses made by IRRI scientists with these varieties were beginning to show great promise in tests at IRRI and other experiment stations in the Philippines. At this time IRRI scientists began discussing ways to test this new technology and make it available to the rice producing countries as soon as possible. Certain Filipino officials who were following the development of the new varieties were also anxious to put the new technology to work to reduce the Philippines' imports of rice. Discussions had begun between these Filipino officials and IRRI administrators on the possibilities of training some of the extension workers of the Agricultural Productivity Commission (APC) in the new technology.

Contacts between IRRI administrators and scientists and Asian rice extension workers in the early years of IRRI's existence had produced an awareness that the capabilities of these workers needed to be improved. Some extension workers on occasion were unable to identify even the damage caused by stem borers, the most common insect pest of rice.

Both IRRI and Filipino officials were aware that the rice extension workers and farmers would have to be taught the new technology and how to apply it. In March 1964 Dr. Wortman offered in an informal meeting with Mr. Oscar Lazo, Chief, APC Information Division, to have IRRI train some of APC's field personnel for 1 year. Mr. Lazo readily accepted the offer.

In May, Dr. Chandler interviewed 10 APC farm management technicians who had been designated as potential trainees. Simultaneously, Dr. Byrnes and Mr. Golden planned the organization and operation of a 1-year training program.

The training program was aimed at preparing these barrio farm management technicians to assume the traditional role of rice specialists Plans were to train one specialist for each of the nine regions and one to serve on the APC Commissioner's staff. Each man was to become proficient in all phases of rice production (soils, entomology, weed control, pathology, etc.), and be responsible for all APC rice activities within his region. He would provide the barrio technicians with technical guidance, trouble-shooting assistance, and periodic refresher training on rice subjects. New information on rice culture would flow through him to the barrio agents in his region; problems beyond resolution at the barrio or the rice specialist level would flow through him to research workers.[1]

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[1]This information was obtained from correspondence between IRRI and Philippine government personnel.

Five of the ten technicians interviewed by Dr. Chandler were selected for the first training class which began in June 1964. These five technicians performed so well that at the end of 6 months the other five technicians who had already been interviewed were permitted to join the group.

The 10 technicians continued to train at IRRI and to travel back to their barrios to establish applied research plots as part of their training. The first five technicians played a prominent role in the training of the second group. At the end of the training course in July 1965, the graduates received their regional assignment and each was assigned to train five farm management technicians. In this fashion the IRRI training program was born.

The IRRI rice production training program has been changing steadily to increase its impact on the spread of the new technology in rice producing countries.

The main objective of the first two classes was to train rice production specialists. Since then the emphasis has shifted to teaching extension workers how to train rice production specialists. Only the first group was trained for 1 year; the succeeding groups have been given an intensive 6-month course. The first 10 trainees were all from APC. There were 28 trainees in the second class. Twenty-five were Filipinos representing a number of agencies; one trainee was a missionary from the U.S.; and the other two were from Africa, one each from Sudan and Nigeria. The third class which started training in June 1967 was the first truly international group. This class of 35 trainees was made up of four Ceylonese, three Americans, one Indian, four Indonesians, two East Pakistanis, four West Pakistanis, and 17 Filipinos. The 1968 class was composed of nine nationalities; 14 countries were represented in the 1969 class; and 12 in the 1970 class.

Since 1964, 177 individuals from 20 countries have graduated from IRRI's 6-month or 12-month rice production training program (Table 2). Many of them have returned to their home countries to organize similar training programs. Training programs are currently operating in the Philippines, Malaysia, Laos, South Vietnam, Pakistan, India, Ceylon, Thailand and U.S.A. Thousands of extension workers and farmers have been trained by IRRI graduates.

In addition to the 177 rice production specialists, IRRI has provided short-term training of from 1 to 2 weeks duration for more than 300 persons. These trainees consist of farmers, missionaries, and scientists who want to know how to produce the new high-yielding rices.

What is the nature of the IRRI training program, why has it caught the imagination of so many people conducting training, and how does it differ from other training programs? To quote Dr. Francis C. Byrnes, "Perhaps what makes these training programs

unique is the communication approach used throughout. This approach recognizes that the primary purpose of the training is to influence human behavior - what people know, how they think, the attitudes they hold, what they do, and their skills and abilities. The training content and process is planned and directed toward achieving specifically defined behavioral changes in the learners."[2]

To me, the outstanding feature of the program seems to be its use of the applied research and growth stages plots to achieve the educational breakthrough. It gives the trainees an opportunity to actually perform all operations required to produce a crop of rice, under the supervision of trained instructors.

As expressed by Dr. Byrnes, "Field experience with different varieties and practices gives the workers conviction and credibility when he talks to farmers. If he cannot grow rice, he finds it difficult to win and maintain the farmer's confidence. It is difficult to teach what one does not know." And expressed so well by Sophocles in 400 B.C., "One must learn by doing the thing; for though you think you know it--you have no certainty until you try."[2]

The trainee in either the 6-month course or the 1- or 2-week course, spends approximately half of all instructional time in the paddies. Individually or in teams of no more than seven, he grows one or more plots of rice, performing all the operations. The growing of the crop of rice by the 1- and 2-week course trainees is made possible by planting of staggered plots so that all growth stages are present.

The IRRI program can be contrasted to the demonstrational in-service type programs which are in vogue throughout the world. These programs provide only limited opportunity for trainees to actually perform the skills of growing a crop. The trainer is seldom able to get all the workers in an area to a demonstration. The trainees must return again and again to the demonstration plot, at the different plant growth stages, if all the operations are to be demonstrated. The attendance problem becomes more and more serious as the demonstration moves toward its conclusion. The demonstration method offers relatively little opportunity for training in the science of crop production so the workers do not gain an understanding of the "why" behind the various operations.

Other important features of the IRRI training program:

1) Diagnostic and written tests to determine a trainee's existing levels of technical competency. These tests indicate to the trainee what he knows and what he does not know. They stimulate him to improve his knowledge since he knows that he will take a similar

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[2]Changing the Change Agent.

examination at the end of the course. These tests likewise indicate the magnitude of the training task.

2) Growth-stage plots to train the 1- to 2-week trainees. This useful and unique idea was first used by Mr. G olden and Mr. Frank Gorrez in East Pakistan in October 1966. It was first used on the IRRI farm in 1967, when the first of seven short orientation sources for 200 persons were conducted. By making a series of staggered plantings so that all stages of the rice plant can be available, the short-course trainees, like the 6-month trainees, can actually perform all the crop operations in a week. At IRRI this is known as the growing of "instant rice.".

3) The opportunity of the trainees to interact with the IRRI scientists. The cooperation of the research staff in assisting with the training program provides the trainee with a valuable opportunity to improve his knowledge of rice science. The trainees soon become familiar with the programs of the various scientists and the scientific terminology peculiar to the different departments. On the basis of such knowledge the trainee can improve his scientific competency.

4) Concentration of the IRRI training program on important variables and problems. For example, in the study of entomology, the trainees concentrate on the stem borers, leafhoppers, and planthoppers because these insects constitute the main problems of plant protection in the Philippines. Other insects are studied, but on a much less intensive basis.

The departure of Dr. Francis C. Byrnes in 1967 and of Mr. William G. Golden, Jr. in 1969 has brought no radical change in the IRRI training program. Trainees are still required to spend about 50 percent of the instructional time in the rice paddies, and about 50 percent in the lecture hall and laboratories learning the science of rice production and how to teach it to others. The most recent changes have been in adjustments in emphasis and additions of certain activities to keep in step with the changing technology.

Some of the more important innovations: development, in cooperation with the proposed lecturers, of specific behavioral objectives for each topic to be taught; requesting the compilation of lecture papers on each topic to make a syllabus on rice production; developing four-step lesson plans to achieve each instructional objective; scheduling the lectures for the entire course and obtaining lecturers in advance of the start of the course, and coordinating and timing the sequence of lectures with the developing rice crop in the field; providing an opportunity for the 6-month rice production trainees to do practice teaching and to organize and conduct a 2-week production course as part of their training; cooperating with Dr. Bradfield to provide 2 weeks of intensive training in multiple cropping; and conducting applied research in rainfed and upland rice culture.

Probably the most important innovation has been the development of training materials for use by IRRI graduates in conducting their own training programs. All papers given by the lecturers in the rice production course at IRRI have been compiled in a two-volume syllabus to serve as resource material for IRRI graduates conducting rice production training. In addition a "Training Manual in Rice Production" has been prepared. It contains all lessons on the skills of rice production. Most of the lectures on the science of rice production have been taped and may be duplicated and made available to IRRI graduates who are conducting training programs. Some exploratory work has been done on the possibility of producing color videotapes of various training activities at IRRI. These tapes would be made available to training centers in rice producing countries. This might be a promising means of supporting IRRI graduates in their training programs.

Conclusions

The dramatic revelations of the testing program at IRRI should heighten the interest of administrators and scientists in doing something to improve the ability of the Asian rice extension workers to help farmers solve rice production problems. Several thousand tests conducted at IRRI or at other places by IRRI graduates reveal that on the average Asian rice extension workers score only about 25 percent on the IRRI practical examination. This examination consists of identifying diseases, insect pests and their damage, nutritional disorders, and the common chemicals used by farmers. This simply means that these workers are wrong three times out of four in identifying the farmers' rice problems. Or putting it the other way around, they are right only one out of four times in identifying the farmers' problems.

Obviously these extension workers cannot help farmers solve their rice production problems. They advise farmers to doctor their crop for a disease when the problem is a nutritional disorder or insect attack, thereby causing farmers to waste their scarce resources. This, no doubt, is the reason why these workers establish little rapport with the farmers and why farmers are reluctant to take their advice. Bad as the Asian extension worker is, however, he is still better qualified than the American advisers sent to assist him. Results from tests conducted at IRRI for 200 short-course trainees between January and July 1967 show that the Filipino field workers scored considerably higher on opening-day tests than did their American advisers. Eight Filipino extension workers scored an average of 57 percent as compared to 3 percent for 11 American Peace Corps Volunteers and 26 percent for seven USAID agriculturists working in Southeast Asia (Table 1).[2]

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[2] Changing the Change Agent.

The conclusions one must draw from these data are that the Asian rice farmers would be better off without these kinds of extension workers and their untrained American counterparts.

However, this situation can be changed rather quickly if these workers are provided with proper training experiences.

Results of the IRRI testing program show also that the diagnostic abilities of the Asian rice extension worker, his American adviser, and others can be changed dramatically with only 1 week of training using the IRRI method.[2] In addition these trainees learn the skills involved in producing rice and gain much scientific information to aid them in diagnosing and solving farmers' rice problems.

This question must be answered: "What is the value of this kind of training and will it really help to get more rice produced?" The answer is not simple. Most often training is only one of several factors involved in agricultural development and it is difficult to separate the contribution of training from the other factors. Dr. Byrnes reports that in West Pakistan rice yields of farmers in areas served by extension workers trained in the IRRI pattern were nearly twice those in areas with conventionally trained workers. Data from various development projects show a big increase in yields where trained technicians have worked with the new high-yielding rices and used the recommended package of practices. But in these cases it is impossible to determine the exact contribution of training.

The countries making the greatest progress in solving their rice production problems have been those that have stressed the adoption of the new high-yielding varieties and the IRRI-type training. The dramatic success of the Philippines in solving their age-old rice supply problem only 2 years after the release of IR8 has attracted the attention of all rice producing countries. The success of West Pakistan and South Vietnam is hardly less dramatic. In all cases, the officials in these countries say that their success flowed from the use of the new high-yielding varieties and the stress put on the training of their technicians by the IRRI method. It may be that the countries that have not made so much progress in increasing their rice output are overlooking one of the essential requirements - the training of their extension workers and farmers in the new rice technology and how to apply it to get high yields. We hope that those concerned will study the situation and that they will realize the importance of the new rice technology and the need to train their workers and farmers.

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[2]Changing the Change Agent.

SELECTED BIBLIOGRAPHY

Aldrich, Daniel G. Jr., Research for the World Food Crisis, American Association for the Advancement of Science, Publication No. 92, Washington, D.C. 1970.

American Society for Training and Development, Training Methods for Skills Acquisition, Madison, Wisconsin: American Society for Training and Development, 1972.

Argyris, Chris, Intervention Theory and Method: A Behavioral Science View, Reading, Mass: Addison-Wesley, 1970.

Arnon, I., Organization and Administration of Agricultural Research, New York: Elsevier Publishing Co., 1968.

Athwal, D.S., "IRRI's Current Research Program" Rice, Science and Man, International Rice Research Institute, Los Banos, Philippines, 1972.

Barker, Randolph, "The International Rice Research Institute and the Evolution of Rice Technology" (mimeo), Los Banos: IRRI, 1971.

Barraclough, Solon and Schaten, Jacobo, "Technological Policy and Agricultural Development (mimeo), May, 1970.

Berg, Sherwood O., "University Training in Agricultural Economics for Foreign Students" Journal of Farm Economics (December, 1959).

Blase, Melvin G. and Paulsen, Arnold, "The Agricultural Experiment Station: An Institutional Development Perspective" Agricultural Science Review, Vol. 10, No. 2 (1972), 11-17.

Borlaug, N.E., "Wheat Breeding and Its Impact of World Food Supply," Proceedings of the Third International Wheat Genetics Symposium, Australian Academy of Sciences, Camberra, 1968.

Bourjaily, Vance, "One of the Green Revolution Boys" The Atlantic Monthly, (February, 1973), 66-76.

Brandt, Karl, "Postgraduate Instruction for Foreign Students" Journal of Farm Economics, Proceedings Number, Vol. XLI, No. 5 (December, 1959).

Brown, Lester, Seeds of Change: The Green Revolution and Development in the 1970's, New York: Praeger, 1970.

Brown, Marion R., "Agricultural 'Extension' in Chile: A Study of Institutional Transplantation," The Journal of Developing Areas, Vol. 4, January, 1970.

Byars, Lloyd L. and Crane, Donald P., "Training by Objectives" in Training and Development Journal, Vol. 23, No. 6 (June, 1969).

Byrnes, Francis C. and Golden, William G., "Changing the Change Agent: A Step Toward Increased Rice Yields," International Rice Research Institute: Los Banos, Philippines, 1967.

Castillo, Leopoldo S., "Graduate Training in the United States as Seen by a National from a Developing Country," Journal of Dairy Science, Vol. 51, No. 2 (1968), 237-42.

Castro, Diosdado V., "The Filipino Graduates of the Rice Production Training Program: A Follow-up Study," M.S. diss., College of Agriculture, University of the Philippines, October, 1972.

Chandler, R. F. in Strategy for the Conquest of Hunger, Rockefeller Foundation Symposium held at Rockefeller University, New York 1968.

Chandler, Robert F., Jr., "IRRI--The First Decade," Rice, Science and Man, International Rice Research Institute, Los Banos, Philippines, 1972, 1-19.

Chang, C.W., "Agricultural Research" Selected Readings to Accompany Getting Agriculture Moving, Vol. 1, Raymond E. Borton (ed.), The Agricultural Development Council: New York, 1966, 210-21.

CIMMYT Annual Report, 1969-70, International Maize and Wheat Improvement Center, Mexico City, 1970.

CIMMYT Program Review, 1972, International Maize and Wheat Improvement Center, Mexico City, 1972.

Cochrane, Willard W., The World Food Problem, New York: Thomas Y. Crowell Co., 1969.

Dalrymple, Dana G., "Imports and Plantings of High Yielding Varieties of Wheat and Rice in the Less Developed Nations" Foreign Economic Development Service, United States Department of Agriculture, Washington, D.C., 1972.

Green, Donald G., "The Experiences of Fourteen Returnees From the International Rice Research Institute," The Ford Foundation: New Delhi, India, September, 1970.

Hardin, Lowell S., "Potential Growth Areas in Agricultural Economics" in Journal of Farm Economics, Vol. 45, No. 5 (1963).

Harris, B.M., et al, In-Service Education: A Guide to Better Practice, Englewood Cliffs, N.J.: Prentice-Hall, 1969.

Heady, E.O., "Priorities in the Adoption of Improved Farm Technology" in Economic Development of Agriculture, E.O. Heady (ed.), Ames: Iowa State University Press, 1965.

Hill, F. F., "Developing Agricultural Institutions in Underdeveloped Countries," Agricultural Sciences for the Developing Nations, A. H. Moseman (ed), Washington D.C.: American Association for the Advancement of Science, 1964.

IR8 & Beyond, International Rice Research Institute: Los Banos, Philippines, 1972.

Kellogg, Charles E., "Interactions and Agricultural Research in Emerging Nations" Agricultural Sciences for the Developing Nations, A. H. Moseman (ed), Washington, D.C.: American Association for the Advancement of Science, 1964.

Kellogg, Charles E., "Interaction in Agricultural Development" Science, Technology and Development, U.S. Papers prepared for the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas, Geneva, 1962, Vol. III, Agriculture, 12-24. (U.S. Government Printing Office, Washington, D.C., 1963).

Kelman, H.C., "Compliance, Identification and Internalization, Three Processes of Attitudinal Change" in Journal of Conflict Resolution, Vol. 2, 1958, 51-60.

Lewis, A.B., "Thoughts of the American Training of Graduate Students of Agricultural Economics from Less Developed Countries," The Council on Economic and Cultural Affairs: New York, 1959.

Lewis, A.B., "Training Foreign Graduate Students in Agricultural Economics" in Journal of Farm Economics, Vol. 49, No. 3 (August, 1967).

Long, E., "Institutional Factors Limiting Progress," in Moseman, A.H., Agricultural Sciences for Developing Nations, New York: American Association for the Advancement of Science, 1964.

Lynton, Rolp P. and Pareek, Udai, Training for Development, Homewood, Illinois: Richard D. Irwin, Inc. and the Dorsey Press, 1967.

Martin, Edwin M., "The Role of Research in the Green Revolution," War on Hunger, Vol. III, No. 9 (September 1969).

McClung, A. Colin, "IRRI's Role in Institutional Cooperation in Asia" in Rice, Science and Man, International Rice Research Institute, Los Banos, Philippines, 1972, 19-40.

McClung, A. Colin, "IRRI's Experience in Cooperative Regional Rice Research" (mimeo), 1972.

McMeekan, C.P., "What Kind of Agricultural Research?" in Finance and Development, Vol. II, No. 2 (1965), 71-78.

Mellor, John W., "Professional Training in Agriculture for Foreign Students" in The Professional Education of Students from Other Lands, Irwin T. Sanders (ed.), New York: Council on Social Work Education, 1963.

Mellor, John, The Economics of Agricultural Development, Ithaca: Cornell University Press, 1966.

Moseman, A. H. (ed), Agricultural Sciences for the Developing Nations, Washington, D.C.: American Association for the Advancement of Science, 1964.

Moseman, A. H., Building Agricultural Research Systems in the Developing Nations, New York: The Agricultural Development Council, 1970.

Moseman, A. H., "Research Needed for Technological Knowledge," Economic Development of Agriculture, Ames: Iowa State University Press, 1965, pp. 224-37.

Mosher, A.T., Getting Agriculture Moving, New York: Praeger 1966.

Poats, Rutherford M., Technology for Developing Nations, The Brookings Institution: Washington, D.C. 1972.

Proceedings of the First Wheat Workshop, International Maize and Wheat Improvement Center: El Batan, Mexico, September, 1971.

Project Review of the Rice Production Training and Research Program, International Rice Research Institute, Los Banos, Philippines, 1971.

Report of the Committee on Research Advisory to the United States Department of Agriculture, National Technical Information Service, Springfield, Va., 1972.

Rice Production Specialist Course, Lecture Syllabus, Vol. 1, International Rice Research Institute, Los Banos, Philippines, 1971.

Rice Research & Training in the 70's, International Rice Research Institute, Los Banos, Philippines, 1969.

Rice, Science and Man, International Rice Research Institute, Los Banos, Philippines, 1972.

Richardson, Ralph W., Jr., "Training of Scientific Personnel" in Rural Development in Tropical Latin America, Ithaca, N.Y.: State College of Agriculture, 1967, 403-12.

Ruttan, Vernon W., "Induced Innovation Hypothesis" in the Annual Report: 1971 Economic Development Center, Dept. of Economics and Agricultural and Applied Economics, University of Minnesota, 1971.

Ruttan, Vernon W. and Weisblat, A.M., "Some Issues in the Training of Asian Agricultural Economics Graduate Students in the United States," in Journal of Farm Economics, Vol. 47, No. 4 (November, 1965), 1024-26.

Sanders, Irwin T. (ed), The Professional Educational of Students from Other Lands, New York: Council on Social Work Education, 1963.

Schultz, T.W., Transforming Traditional Agriculture, New Haven: Yale University Press, 1964.

Sills, David L., "The Succession of Goals," in Etzioni A., A Sociological Reader On Complex Organizations, Second Edition, New York: Holt, Rinehart and Winston, 1969.

Simon, Herbert, "On the Concept of Organization Goals," in Etzioni, A., A Sociological Reader on Complex Organizations, Second Edition, New York: Holt, Rinehart and Winston, 1969.

Singer, Hans W., "A New Approach to the Problems of the Dual Society in Developing Countries," United Nations International Social Development Review, No. 3, 1971.

Southworth, H. M. and Johnston, B. F., Agricultural Development and Economic Growth, Ithaca, New York: Cornell University Press, 1967.

Stakman, E. C., Bradfield, Richard and Mangelsdorf, Paul C., Campaigns Against Hunger, Cambridge, Mass.: The Belknap Press, 1967.

The International Rice Research Institute Annual Report for 1968, 1969, 1970, 1971 and 1972, International Rice Research Institute, Los Banos, Philippines, 1968, 1969, 1970, 1971, 1972.

The Training Program, The International Rice Research Institute, Los Banos, Philippines.

Thompson, Kenneth, "The Green Revolution" in The Center Magazine, Vol. VI, No. 6 (November/December, 1973) 56-66.

Training of Research Workers in the Medical Sciences, World Health Organization: Geneva, 1972.

Wharton, Clifton R. Jr., "The U.S. Graduate Training of Asian Agricultural Economists," The Council on Economic and Cultural Affairs, Inc., New York, 1959.

Wheat Breeding Training Manual, International Maize and Wheat Improvement Center: Mexico City, 1972.

Wilcke, H. L. and Sprague, H. B., "Agricultural Research and Development by the Private Sector of the United States," in Agricultural Science Review, Vol. 5, No. 3 (1967), 1-8.

Wortman, Sterling, "The Technological Basis for Intensified Agriculture," in Proceedings of a Conference on Agricultural Development, The Rockefeller Foundation: New York, 1969.