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REPORT OF THE JOINT PAKISTAN AMERICAN

agricultural research

REVIEW TEAM

ISLAMABAD

APRIL 6, 1968

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Rawalpindi
April 6, 1968

Mr. A. H. M. Shams-ud-Doha
Minister for Agriculture and Works
Government of Pakistan
ISLAMABAD

Honorable Minister,

It is a pleasure to present herewith the Report of the Joint Pakistan-American Agricultural Research Team.

The visit of the Pakistan Members of the Team to the United States and of the American Members in Pakistan has given us a mutual understanding of the problems and potentials of agricultural research.

Pakistan is now increasing agricultural production at a truly remarkable rate. Our Report is directed to the further development of Pakistan research institutions and programs to assure a continuing flow of new but proven technology to your farmers. It should make possible annual increases in agricultural output of four per cent or more for the next 10 to 20 years.

The Team has had the assistance of numerous Pakistan scientists and officials. We trust the Report reflects their wisdom and that it merits their support.

Your's sincerely,

M. Yamin Qureshi

Zafar Ali Hashmi

Frank W. Parker

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**REPORT OF THE JOINT PAKISTAN-AMERICAN
AGRICULTURAL RESEARCH TEAM**

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SUMMARY AND RECOMMENDATIONS

This study of agricultural research resulted from the visit of President Ayub to the United States in 1965. It reflects the President's concern that Pakistan have the continuing flow of new and proven technology that is required as a basis for maintaining an annual increase in agricultural output of four or more per cent for a long period of time.

The study was made by a Pakistan-American Team and involves a study of agricultural research with special attention to organization, administration and needs in both countries. The principal objective of the study are given in Chapter I.

The Report gives a brief summary of important developments in agricultural institutions and output since 1960, discusses research needs in eight major fields, examines research facilities and administration in Pakistan, and gives recommendations for their improvement.

Pakistan's agriculture is undergoing revolutionary changes initiated by a combination of research and dynamic policies of the government. The country has a good agricultural research base on which it can build the type of research institutions and programs that will be needed to sustain the agricultural revolution for the next 20 years. The following recommendations are offered as a partial guide to the continued improvement of agricultural research in the country:

- No. 1 The Pakistan Agricultural Research Council should be organized in the pattern of Pakistan Council of Scientific and Industrial Research to provide for more flexibility in planning, support, coordination and conduct of research in the many complex problems in the nation's agriculture. The proposed objectives and organizational structure of the Council are shown in *Appendix VI*.
- No. 2 In view of the deficient status of agricultural research in the Province, the urgent need for improved facilities, staff and progress, the Team recommends the establishment of a Special Committee of the A.R.C. to advise in the planning, implementation, coordination, and evaluation of agricultural research in the Province. (East Pakistan).
- No. 3 Department of Agriculture, East Pakistan, should explore the possibility of organizing an East Pakistan Agricultural Research Association or Society which must be composed of institutions engaged in agricultural research including selected non-governmental institutions, to facilitate a periodic and regular review of programs and problems of mutual concern.
- No. 4 The heads of the institutions concerned with research at each location in the Province should develop a Memorandum of Cooperation, to go to the Secretary of Agriculture for approval, which would provide the formal basis for cooperative work. The Memorandum should be amended from time to time as the fields of cooperation increase or change. (West Pakistan)
- No. 5 The Department of Agriculture should explore the possibility of organizing a West Pakistan Agricultural Research Association or Society, with membership composed of institutions engaged in agricultural research, including

selected non-governmental institutions, to facilitate the periodic and regular review of programs and problems of mutual concern.

- No. 6 Vigorous action should be taken by appropriate officials of the Government of West Pakistan to correct the procedures for planning and implementation of research, including the arrangements for financial sanctions, and such other factors which limit the effectiveness of research in the Province.
- No. 7 The opportunities for substantial returns from additional investments in research are most promising in a wide range of problem areas. Appropriate government officials and leaders of research organizations should make a strong mutual effort to explore and fund such opportunities.
- No. 8 The development of a uniform schedule of salaries and improved selection and promotion procedures based on merit should be undertaken by the Pakistan Agricultural Research Council in collaboration with appropriate representatives of the two Provincial Governments. The assistance of a consultant from the Personnel Division of the USDA Agricultural Research Service would be most useful in this effort.
- No. 9 Special steps should be taken by the Agricultural Research Council to support tours abroad for Pakistan scientists to study organization and administration of research, and also to establish special courses in agricultural research administration in the National Institutes for Public Administration.
- No. 10 The accelerated programs for increasing production of wheat and rice must have more effective back-stopping from research to insure reliable guidance in adapting the introduced technology to Pakistan conditions and to furnish prompt attention to uncertain pest and disease hazards. Special attention must be given to the support of these projects for rapid development of essential research facilities, for provision of qualified staff, and for the flexibility in cooperative arrangements that will insure maximum progress in supplying a more adequate research base for these important food grain production programs.
- No. 11 A coordinated research program for improvement of cotton production, with combined attention to breeding of improved varieties, control of pests and diseases, and to soil fertility and water management, should be planned and carried out by the Central Cotton Committee in cooperation with the Agricultural Research Council and other appropriate organizations.
- No. 12 Coordinated research programs should be developed by the appropriate research organizations for selected problem areas discussed in Chapter III, including (1) soil fertility, (2) water use, (3) crop protection, and (4) farm power and mechanization.
- No. 13 The Agricultural Research Council should furnish support and take positive leadership in stimulating the attendance of agricultural scientists at international conferences and in arranging for appropriate study tours to keep Pakistani scientists in contact with research advances abroad.

- No. 14 A representative of the U.S. Department of Agriculture Library, which has established an extensive national and regional computerized documentation system should be obtained as a consultant to assist in developing a national documentation system for agricultural research and related subjects.
- No. 15 A specialist in plant introduction from the U.S. Department of Agriculture should be obtained to assist with the planning of improved plant introduction procedures, staff, facilities, and implementation.
- No. 16 A Board of International Agricultural Science Consultants should be appointed, to meet annually for a two-to-four-week period in Pakistan, to assess the progress in agricultural research and to advise regarding new developments abroad. One member of the Board might be a full-time science adviser to the Agricultural Research Council, stationed in Pakistan, and serve as the secretary of the Board. This Board also would be expected to advise Pakistan research and administrative officials of the quality, and of the deficiencies, in Pakistan's agricultural research.
- No. 17 Technical staff from research institutes and experimental stations should be provided opportunities to improve their professional capability by taking post-graduate work at the agricultural universities. The Agricultural Research Council should give special attention to fostering and supporting such programs through award of scholarships or fellowships.
- No. 18 One or more neighboring areas should be assigned to each agricultural university for intensive work, on a pilot scale, to develop integrated programs of teaching, research and extension covering both the natural and social sciences affecting agricultural development.
- No. 19 The Agricultural Research Council should make special provision for research grants to the Agricultural Universities, including funds for equipment and operation of research projects.
- No. 20 The East Pakistan Agricultural University farm should be developed as rapidly as possible through the use of land planes and other modern equipment required for the proper preparation of irrigated farm for experimental work.
- No. 21 The facilities and staff resources of the general universities, the agricultural universities and the colleges of agriculture should be considered and utilized to the maximum extent possible in the location of research units or institutes, in the grants for specific schemes related to agriculture, and in planning coordinated research schemes in which a number of institutions may participate.
- No. 22 The Dacca Agricultural College should be developed as a *constituent* college of the East Pakistan Agricultural University, as a second campus. Similarly, the Animal Husbandry College at Lahore should be developed as a constituent college of the West Pakistan Agricultural University.

No. 23 The cooperation between the West Pakistan Agricultural University, the Agricultural College, Tandojam, and the Peshawar Agricultural College should be developed to improve staff development and training, including training abroad.

No. 24 In order to strengthen the communication and coordination between research and extension it is proposed that extension subject matter specialist positions be established in each extension region of Pakistan. There should be specialists in agronomy (field crops), plant protection, soil and fertilizers, animal husbandry and other subjects as needed. They should be located at the regional research institutes and/or in the agricultural university or college of their region.

REPORT OF THE JOINT PAKISTAN-AMERICAN AGRICULTURAL RESEARCH TEAM

CHAPTER I

INTRODUCTION

The joint Pakistan-American Team on Agricultural Research originated from the visit of President Mohammad Ayub Khan to the United States in December, 1965.

At the White House dinner on December 14, President Johnson expressed his concern about the growing problem of poverty, hunger, disease and illiteracy around the world. He called attention to President Ayub's mutual view that these human and physical problems "cannot be resolved by the magic wand of just freedom alone."

President Johnson offered the services of his science adviser, Dr. Donald Hornig, with a team of medical teachers and scientists to work with Pakistan medical authorities in improving rural and public health services in the country.

In responding, President Ayub referred to the great benefits from the team of U.S. scientists sent to Pakistan in 1962 to assist with the problems of waterlogging and salinity. In further reference to food and population problems he stated: "Similarly with our agriculture, and so on, results have been very heartening. And so any advice and assistance of that nature will be most welcome, in keeping with the wishes and the desires and the endeavors of the people."

The text of the exchange of toasts between President Johnson and President Ayub is attached in *Appendix I*.

On April 30, 1966, at the termination of the visit of Dr. Hornig and his medical science colleagues in Pakistan, they met with President Ayub and identified a number of specific problem areas for further joint attention. These related primarily to health services, science education, and family planning. But reference was made also to agricultural technology in the future development of Pakistan, and Dr. Hornig advised that the U.S. was prepared to send three or four American experts to join with Pakistan experts, to conduct a review of the current efforts in the field of agricultural research to determine what might be done cooperatively to strengthen them.

Dr. Abdus Salam, science adviser to President Ayub, maintained contact with appropriate U.S. Government officials to insure follow up action on the agricultural research review.

Team Membership and Procedures

Arrangements for the Joint Team were tentatively agreed upon during the CENTO Conference on National and Regional Agricultural Development Policy, held in Istanbul on September 15, 1967. The membership of the team, with their biodata, is given in *Appendix II*.

The three Pakistan members of the team were in the United States from February 2 to 25, 1968, and visited research institutions of the U.S. Department of Agriculture, the Land Grant Universities, private foundations and industrial organizations to obtain first hand information about planning, organization, coordination and conduct of agricultural research and related services in the United States.

The itinerary, with institutions and individuals contacted, is shown in *Appendix III*, and the Summary of Observations of the Pakistan team members in *Appendix IV*.

The four American members of the Joint Team were in Pakistan from March 13 to April 6, 1968, to conduct a similar review of research institutions and organizations. The itinerary, with institutions and individuals contacted, is shown in *Appendix V*.

Terms of Reference

The terms of reference of the Joint Team were reviewed with Secretary S. A. M. Khan, Ministry of Agriculture and Works, at Islamabad on Thursday, March 14, 1968. The charge to the team was to determine the administrative and organization measures to be recommended in order to achieve the following objectives:

1. Improve national and/or provincial-wide coordinated research programs in given fields or problem areas.
2. Assure inter-disciplinary research efforts for simultaneous attention to related aspects of agricultural development.
3. Assure effective coordination of research with regulatory work, marketing services, extension, development and national planning.
4. Increase and improve the training of students for careers in agricultural research, education and extension, including administration of agricultural programs.
5. Provide for more effective linkage with new technology of other countries and from the specialized international agricultural research centers.
6. Improve incentives for young men to engage in professional careers in agricultural development.
7. Explore the adequacy of research services, including trained scientists, field and laboratory facilities and equipment and operating budgets for a sustained flow of new technology for improving agriculture.
8. Assure a research program that will meet the need of the major segments of Pakistan agriculture, namely, production and marketing of field and horticultural crops, livestock, forestry and fisheries products, and conservation and use of natural resources.

The Joint Team did not assess performance of individual research projects or the detailed needs for budgetary support, facilities or equipment of selected laboratories or institutes. Attention was focussed on such deficiencies generally, and on problems of organization and procedure which have broad significance in the effectiveness of agricultural research in Pakistan.

Organization of the Report

Chapter II gives a brief account of agricultural development in Pakistan since 1958, with special attention to institutional development and research. It concludes with a statement of some of the major research deficiencies recognized by the Team.

Chapter III is a review of eight problem areas that require further research emphasis. These are *indicative* of fields requiring new technology inputs and the review is not intended to identify all such problems confronting agricultural development in Pakistan. The emphasis is on further research needs rather than on what has been accomplished.

Chapters IV, V and VI provide an analysis of means for improving research support, planning, execution, development and coordination, with specific recommendations on these matters.

Chapters VII and VIII consider relationships of the government supported research with international research agencies and programs, and with the rapidly expanding agricultural industries of Pakistan.

Chapter IX is concerned with the agricultural universities and colleges. It includes suggestions for their further improvement and participation in research.

Chapter X discusses problems and means of transmitting research results to farmers, and Chapter XI offers suggestions for the implementation of the report.

CHAPTER II

AGRICULTURAL DEVELOPMENT IN PAKISTAN, 1958-68

The change of government in 1958 was followed by an acceleration of economic development in all sectors of the economy. In July 1959 the President appointed the Food and Agriculture Commission, a body of distinguished Pakistan and foreign officials and specialists. The Commission's report of November 1960 is a comprehensive document and is one of the important guidelines for agricultural development in the present decade. The Team has considered the Commission's report as a bench mark and has addressed itself to changes since 1960. A number of important changes in institutional development, production and research have already been accomplished.

Institutional Development

The Agricultural Development Corporation was organized as recommended by the Commission. This served to separate the procurement of supplies and operational functions from that of extension education. The Provinces, therefore, have been able to give more attention to promoting practices for increasing production.

The Water and Power Development Authority (WAPDA) was organized in 1958 and provides for a broad scale approach to complex problems in these fields. Many of its projects are devoted to increasing the resources available to agriculture. Of special significance are the Salinity Control and Reclamation Projects in West Pakistan. These include substantial operational research. Since 1959, several hundred thousand acres have been reclaimed in SCARP I, waterlogging largely eliminated, and crop yields doubled.

The Agricultural Development Bank of Pakistan was established in 1960-61 by merger of two financial organizations. It makes loans for storage, warehousing, processing of agricultural crops and is a source of loans for farmers. Its capital has been greatly increased and it is steadily enlarging its service to the agricultural sector.

An agricultural university has been established in each Province. These universities have developed rapidly with respect to facilities, staff and program, including postgraduate work and some research. They have effectively utilized foreign assistance. The institutions, as indicated in Chapter 9, are becoming strong centers that can provide most of the highly trained manpower required for continued agricultural development.

The first Basic Democracies were formed in 1961 and have increased in number, power and influence on agricultural production and development. As representatives of the farmer, they will be increasingly concerned that he benefits from good research and extension work.

Agricultural Production

Pakistan has made rapid progress in increasing agricultural production during the past 10 years. The growth in total production compares most favorably with the more rapidly developing nations of the world.

The trend of increased output since 1959-1960 is well summarized in the following table from a report of March, 1968, prepared by Dr. Oddvar Aresvik, the Ford Foundation Adviser to the Planning Cell, Agriculture Department, Government of West Pakistan:

**Growth in Agricultural Value Added, 1947/48 to 1964/65, All Pakistan
(in 1959/60 prices)**

	Trend Rates of Growth per Annum*	
	1949/50 to 1958/59	1959/60 to 1964/65
Total Agriculture	1.1	3.2
Major crops	1.0	3.6
Minor crops	1.1	3.6
Livestock	2.2	1.9
Forestry	2.3	3.2
Fishery	6.2	4.9

* Least squares estimate of "b" in the equation: $\log Y = a + b \cdot \text{time}$.

Source:—Statistical Bulletin (27), August, 1965, pages 932-3.

The tripling of the agricultural growth rate, from 1.1 per cent prior to 1960 to 3.2 per cent in recent years is a remarkable achievement. Many factors are involved in this creditable rate of progress including the improved utilization of land and water resources, the expansion in tubewells, and the increased use of fertilizer and other production inputs. Of equal importance is the series of changes in policy which increased incentives to farmers through guaranteed prices and subsidies for production inputs.

The high priority assigned to agriculture in the Third Five Year Plan and the personal attention of President Mohammad Ayub Khan and other government leaders have been major factors for progress in this sector. The marshalling of organizational and administrative efforts to insure the availability to farmers of the new varieties, fertilizers and other inputs continues to present difficulties because of the rapid expansion in the use of new food grain production techniques, but these will be surmounted with further research and experience.

Research

The report of the Food and Agricultural Commission identifies many problems relating to the planning, organization and coordination of research. It also includes important recommendations including the following:

1. Agricultural research should be planned on a national basis with emphasis on research to increase production. The Central Government, through the Ministry of Food and Agriculture, should assume greater responsibility for research.
2. There should be a regular cadre of research workers from the grade of research assistant to director of research who would not only be head of the Research Department but also responsible for coordinating research with extension.

3. The Agricultural Research Council should consist primarily of scientists from government departments, universities and other public and private research organizations.
4. The Pakistan Central Cotton Committee and the Jute Committee should be abolished and amalgamated with the Agricultural Research Council with special council committees looking after the interests of these principal foreign exchange earners.
5. There should be two major lines of research, namely: research in the natural sciences and in economics. A separate section of the Council should be in charge of evaluation and publishing results of research.

Since the Commission Report the Central Government has reduced its research functions, with some Central Institutes transferred to the Provinces. Problems of coordination have, therefore, been increased rather than resolved.

The improvement in agricultural research capability in the past decade has been minimal and little has been done to follow up or implement the constructive recommendations on research of the Food and Agriculture Commission of 1960.

Continuing Deficiencies in Research

The terms of reference for the Joint Team have made it desirable to focus more on the deficiencies in research rather than on the research capability of the country. It is only by a recognition and analysis of deficiencies that recommendations for improving and accelerating the research program can be developed. The Team, therefore, trusts that in view of the Team's assignment Pakistan scientists and officials will not consider the subsequent chapters of this report unduly critical.

The deficiencies observed by the Team may be usefully grouped into two categories, (a) those associated with administration and (b) those related to the conduct and coordination of research. The former must be corrected by basic changes in governmental procedures, or by the development of semi-autonomous research organizations which can use more flexible procedures than government. The second group of deficiencies may be corrected under either form of organization.

The principal deficiencies in agricultural research administration appear to be:

- (a) the low status of agricultural scientists and specialists in the governmental hierarchy,
- (b) the lack of incentive to scientists due to failure to reward merit in selection, promotion and salary,
- (c) failure to delegate authority at all levels, and
- (d) time-consuming procedures, especially in matters of financial sanctions and in the selection and assignment of personnel.

Other deficiencies are:

- (a) lack of adequate research in some important subjects or problem areas,
- (b) inadequate funds, and undue delay in making funds available,

- (c) lack of cooperation within universities and research institutes and between research agencies at a given location or within a region,
- (d) inadequate staff and insufficient attention to staff development,
- (e) inadequate linkage with international research programs and foreign research agencies, and
- (f) lack of effective liaison with agricultural extension and development agencies.

The subsequent sections of the report will further analyze these deficiencies and suggest means for correcting them.

CHAPTER III

PROBLEM AREAS IN NEED OF FURTHER RESEARCH ATTENTION

Although creditable progress has been made in some lines of agricultural research in Pakistan in recent years there are a number of important gaps in the development of improved technology essential for progressive agricultural development.

The eight problem areas discussed in this Chapter are not listed in order of priority and are not intended to be all inclusive. Other aspects of the agricultural sector, including forestry and fisheries, would benefit greatly from more effective research attention.

The degree of seriousness in lack of adequate research varies among the items selected, ranging from the possibility of damaging losses in production to reduced efficiency in use of agricultural resources. In all cases modest investments in research would return substantial benefits in terms of protection and productivity of Pakistan agriculture.

The Accelerated Programs for Wheat and Rice Production

Pakistan is most optimistic regarding prospects for self-sufficiency in food production by 1969 or 1970. The foundation for this is the new crop production technology for wheat and rice, imported as essentially ready-made package programs of new varieties and practices from the coordinated wheat improvement research scheme conducted for many years by the Government of Mexico and the Rockefeller Foundation, and from the International Rice Research Institute in the Philippines.

Pakistan's progress toward self-sufficiency in food grains is widely recognized throughout the world—and properly so—as an outstanding advance accomplished by giving high priority to agriculture and by furnishing vigorous leadership from top government officials. There are, of course, certain calculated risks in this accelerated program, in which biological forces are involved, and safeguards must be taken as promptly as possible to protect the advances made.

The research backstopping for this program is in need of further strengthening if potentially serious losses in the future are to be avoided. The Team feels it is desirable to present views on the nature and possible seriousness of some of these hazards, to encourage a greater sense of urgency in fortifying the research program. These views are not to be construed as critical of the present and past accomplishments. They are directed toward the future.

Crash programs in any country for a rapid introduction of exotic crop varieties without adequate previous testing are hazardous, especially because of the threat of indigenous pests and diseases. In the United States and in other agriculturally advanced nations no crop variety is approved for distribution to farmers without a minimum of three years of testing over a wide range of environments, to identify potential weaknesses of the new variety.

The dynamics of crop pathogens is well illustrated by the sequence of diseases which attacked the oat crop in the United States in the decade beginning in 1945. High-yielding, short-strawed varieties selected from hybrids involving the *Victoria* parent strain from Australia, were accepted enthusiastically by farmers. Four years after their introduction, in 1945, they covered about 90 per cent of the oat acreage in Iowa and in areas of adjacent states.

A new form of *Helminthosporium* appeared, causing losses of 25 per cent of the oat crop in 1946 and 32 per cent in 1947. The rapid replacement of the varieties with *Victoria* parentage, by varieties resistant to the disease, reduced the loss to only one per cent in 1948. But the newly introduced varieties proved to be susceptible to Race 45 of crown rust, and to *Septoria* blight, which caused losses ranging from 15 to 30 per cent between 1949 and 1953.

The speed with which virulent plant pathogens can reach epidemic proportions, in areas planted to a single variety or to a few closely related varieties, is demonstrated also by the experience in the United States with the Race 15B of stem rust of wheat which was first observed in farmers' fields in 1950. This disease built up to massively destructive proportions in 1953 and 1954 when 60 to 75 per cent of the potential durum wheat crops in the country were destroyed.

The above losses occurred in spite of a long history of outstanding research on cereal rusts by the U.S. Department of Agriculture, the University of Minnesota and the Dominion Rust Laboratory at Winnipeg, Canada. The losses were curbed only after action was taken by the U.S. Department of Agriculture to (1) strengthen the nationwide plant disease detection services, (2) increase the research staff in plant pathology and plant genetics to accelerate the identification of new sources of resistance in the host plant, and (3) improve the capability of the cooperative federal-state crop breeding programs to incorporate promptly the disease resistance factors into acceptable commercial varieties.

The cereal rusts have been damaging in the past in Pakistan and can be expected to be so in the future. An excellent summary of the nature and extent of this problem is presented in the journal, *Agriculture Pakistan*, Volume VI, No. 4 for December, 1955 in the article "Wheat Rusts in West Pakistan" by Abdus Sattar and Abdul Hafiz, pages 52-63. This report states that in 1947-48 the wheat crop was reduced by two million tons in the Indo-Pakistan subcontinent as the result of widespread rust damage. In 1953-54, another epiphytotic year, the combined leaf, stem and stripe rust attacks reduced both yield and quality of the crop. And in 1958-59 stripe rust infection damaged the wheat crop in the northern areas of the Province. As pointed out in the paper by Sattar and Hafiz, "Such epiphytotic years, although not common, are repeated almost after every 5 or 6 years."

Mexipak wheat was under limited test beginning in 1962, so that data on adaptation were available before the rapid expansion in acreage of this variety in 1966 and 1967. But Mexipak is susceptible to the rusts in Mexico and in 1966 one collection of Race 42 of black stem rust was made from a field of Mexipak in Pakistan. In 1967 a number of collections of Race 42 were made in Mexipak fields. Rust damage has been minimal in 1968 but the future is uncertain. With a susceptible host variety grown over widespread acreages, and a virulent pathogen present, the extent of infection and damage will depend largely

upon weather factors in the next two or three years, the time required to increase and distribute seed of the new varieties resistant to Race 42 which are now being developed in the research programs in Pakistan.

Pakistan must strengthen the participation of plant pathologists in the coordinated wheat scheme which is now largely concerned with plant breeding and has only limited participation of the other scientific disciplines. There must be maximum flexibility in associating pathologists, soil scientists, and water research specialists with the coordinated wheat research scheme; more flexible and assured budgets for travel and mobility of the research staff; and an annual conference of the research workers to assess progress and to review problems in this province-wide scheme.

In the case of rice, there are still many unknowns about the potentials and the limitations of the IRRI varieties in East Pakistan. These varieties have not had the minimum of three years or seasons of field trials in that region, in keeping with sound practice of plant breeders. The rapid expansion of planting of the new varieties in East Pakistan provides a situation where promotion has moved far ahead of research and effective guidance to farmers.

The extent of the disease and pest hazards is uncertain. Bacterial leaf blight, and bacterial leaf streak could become damaging. The Tungro virus disease also is present and an IRRI pathologist has identified two new virus diseases on the introduced varieties in Pakistan which had not previously been observed by the IRRI staff. These problems must be solved through a vigorous research program.

The International Rice Research Institute continues to emphasize in its reports the need for cooperating countries to develop strong adaptive research programs to test suitability of the varieties to local environments and to meet disease and pest hazards.

The facilities and the staff at the Agricultural Research Institute at Tejgaon, Dacca, are not adequate for the task. Plans for a new rice research laboratory and field station at Joydebpur have been developed and this facility must be established at the earliest possible date.

Fertilizer Use

The Third Plan provides for increasing fertilizer consumption from 162,000 tons of nutrients in 1964-65 to 484,000 in 1969-70. (The revised target for 1969-70 is 720,000 tons.) The Plan indicates that fertilizers will produce 35 per cent of the estimated increase in agricultural production and their importance is also indicated by the magnitude of the capital requirements for production and use. In the Third Plan these will be about Rs. 1,400 million and Rs. 1,167 million.

Fertilizer requirements for the major crops and soils have been determined in a general way by the data secured from many thousands of trials in cultivators' fields under the rapid soil fertility scheme which has been in progress since 1958. These trials, however, were not conducted with the new high yielding varieties, or with the pest control, proper irrigation, and other improved practices required to produce really high yields.

The field work has not been fully related to soil series or to chemical properties such as the level of available nutrients. Sufficient attention has not been given to fertilizer placement, time of application, and the need for secondary and minor elements. Fertilizer use on non-irrigated crops, the effect of fertilizers on root systems, and the efficiency of water use have had very little study.

Research on fertilizer use needs to be expanded at many locations in both Provinces. It should be an integral and important part of all coordinated crop improvement schemes. In addition, there should be a coordinated national scheme on fertilizer use to provide for the correlation of crop response with the nutrient status of soils and for determination of the residual effects of fertilizers applied to one crop upon the succeeding crops. Soil testing services, correlated with field trials, should be established at research institutes and at the universities.

The Pakistan fertilizer industry is developing rapidly and will be large and influential in the agricultural sector by 1975. One industrial organization has made a substantial beginning in fertilizer research and others will undoubtedly do so as their plans mature. This affords a unique opportunity to have a coordinated or cooperative government-industry fertilizer research program. This would be facilitated by the development of the proposed national coordinated scheme on soil fertility in which industry should participate. Such a scheme should provide for an annual conference of the scientists immediately involved, including the agronomists, extension specialists, sales managers and others concerned with promoting the better use of fertilizers.

As indicated by the F.A.O. the use of fertilizers is a "Lead Practice". Research on fertilizer use should be associated with good plant protection, improved seed, and other elements of modern technology appropriate to local conditions. The association of industry, crop scientists, agriculture economists, and extension specialists with the fertilizer research program will help in the effective development and use of the proper packages of practices.

The benefits of such a research approach are difficult to assess but it seems reasonable to assume a potential increase in efficiency of fertilizer use of at least 25 per cent. Such an increase, applied to the large investments indicated above, would represent a substantial savings and return to Pakistan's economy. This research also would furnish essential guidance for the continued expansion of the industry.

Water Use

The development of irrigation in West Pakistan has been handled primarily by engineers concerned with the construction of dams and large irrigation canals. There is a paucity of research on management of water and on the water requirements of the various crops grown in this region.

Knowledge on the time, frequency and amount of irrigation to produce maximum yields and top quality products must come from research under Pakistan conditions. Research on these problems should be conducted in a coordinated program by the Regional Research Institutes and should be expanded as rapidly as qualified personnel become available.

Recommended practices from this research program will be required to (1) improve efficiency and avoid waste of irrigation water, (2) avoid over-irrigation which contributes to the existing problem of waterlogging and salinity and (3) guide extension workers for more effective demonstrations of effective practices to the cultivators.

There is an increased interest in irrigation in East Pakistan during the Boro season when the production of rice and other crops could be enhanced substantially by the assured supply of water from low lift pumps and tubewells. At the present time there is little or no research information to guide the efficient use of water in this type of irrigated agriculture.

WAPDA and SCARP offer excellent organizational bases through which problem-oriented research on water use and soil management could be strengthened in West Pakistan.

The Agricultural Universities should establish courses and also conduct research associated with teaching on water management and on the water requirements of plants. It may be necessary to arrange for the training of some Pakistan professors and scientists abroad, selecting engineers, agronomists, soil scientists and plant scientists for specialized training in fields related to water use problems.

Crop Protection

There is a widespread recognition throughout Pakistan of the serious problem of losses due to pests and diseases in agricultural crops and livestock.

Dr. Khawja Abdul Haq, Entomologist of the Ayub Agricultural Research Institute at Lyallpur, in his presidential address to the Entomology Section of the Twentieth All-Pakistan Science Conference at Dacca University on March 4, 1968, referred to the recent compilation (Cramer of Bayer Co., 1967) of crop losses due to pests. These losses, for the various regions of the world have been tabulated as follows:

Region	Losses due to:			
	Insects	Diseases	Weeds	Total
	(per cent of potential production)			
North and Central America	9.4	11.3	8.0	28.7
South America	10.0	15.2	7.8	33.0
Europe	5.1	13.1	6.8	25.0
Africa	13.0	12.9	15.7	41.6
Asia	20.7	11.3	11.3	43.3
Oceania	7.0	12.6	8.3	27.9
USSR and P.R. of China	10.5	10.1	10.1	29.7
Average	12.3	11.8	9.7	33.8

Dr. Haq calculated the monetary loss in terms of national income for Pakistan as follows:

"Taking the figure of loss for Asia as a standard for Pakistan, and taking the national income of our country in the sector of major and minor crops for 1965-66, which was Rs. 1442.5 crores, as the basis, the annual loss to our crops in Pakistan due to insect pests, diseases and weeds works out to Rs. 1101.6 crores. Even if the lower figure of 33.8% loss, which represents the world average, is taken into account, the damage under reference in our country would work out to Rs. 736.5 crores."

It is estimated that Pakistan will spend Rs. 58.5 crores on crop protection during the Third Plan period.

There is ample evidence from discussions with research workers and others concerned with pest control that information to guide effective control of pests and diseases for many of the major crops, including cotton and rice, is inadequate. This lack of information is common with respect to efficacy of pesticides, on proper doses, and on timing and frequency of application.

Research is needed on the health hazards involved from pesticide residues, and on quality control to ensure effective formulations. There is need also for more accurate data on the cost of various means of controlling insect pests, rodents and weeds.

New techniques for control through more effective attractants and sterilants, and other biological control measures should be investigated. Ground machines and hand operated spraying or dusting equipment, including new low volume spray techniques, should be evaluated and designed to suit the power and cropping conditions in Pakistan.

The special Plant Protection Review Team on crop protection requested by the Government of West Pakistan, in its report to the Government on December 15, 1967, stated:

"It is obvious that plant protection as it is now being conducted by the public sector is inadequate and inefficient."

The Team recommended that private industry be given a greater role in crop protection operations, in view of the massive dimensions of the crop protection task throughout the country. It is apparent that public organisations cannot handle this job and private industry should be encouraged to take a larger role.

The Plant Protection Review Team also stated:

"We feel that pest control, as now practiced, is not based on adequate research findings. Effective insect control programs include sound biological, field evaluations of the current pest problem by highly qualified professional personnel. The future success of any valid plant protection program is dependent upon the utilization of the services of competent scientists assigned specifically to these duties."

"Field research is positively essential for any realistic solution of a practical pest control problem. It is evident to us that properly conducted field research has been insufficient in West Pakistan."

The research to guide more efficient control measures, to protect against hazards to humans or beneficial animals, and to ensure standards of quality and performance should be conducted through a stronger research program supported by the Central Government. These problems are nationwide and not limited to a single province or region. The objective is to develop effective systems of control for all pests attacking a crop rather than a method of control for a single pest.

If a central "Directorate" or institute is established, as proposed by the Plant Protection Review Team, a strong research program should be one of the major components of this center. In addition, entomologists and other plant protection specialists should participate fully in the various coordinated crop improvement schemes.

The insect problems are specific for each crop, or type of livestock, and differ in the various cropping environments, so well planned field research should be carried out wherever the pest problems exist.

Diversification

The prospective attainment of self-sufficiency in food grains will afford Pakistan an opportunity to further diversify agricultural production. Some land, labor and other resources now used for food grains can be shifted to other crops including oil seeds, pulses, feed grains, forage, cotton, jute, vegetables and fruits. Diversification would include also an expansion in production of poultry, dairy and other livestock.

Pakistan recently served as host to the CENTO Nutrition Seminar attended by experts from Iran, Turkey, Pakistan, the UK and the USA. This reflects a deep awareness of the need to improve nutrition, particularly through increased use of high protein and protective foods.

At the present time, Pakistan is deficient in vegetable oils and protein. Efforts to introduce new oil and protein crops have not been conducted on a well-organized basis. Research on these crops has been limited and almost none of this research has involved attention to the several disciplines required to bring about practices to improve production. A coordinated research scheme associated with the Regional Grain Legumes Improvement Project which was initiated in 1963 at Karaj College in Iran, under USAID support, would permit rapid progress in developing improved varieties and production practices.

The prospects for more effective research on the rough grains including maize, sorghum, and millets, by utilizing germ plasm or varieties and new production practices from other countries are excellent. Within a few years Pakistan could be as far along with the improved production of these crops as it now is with wheat, if coordinated research schemes are established.

As economic development proceeds in Pakistan there will undoubtedly be increased demand for meat and other livestock products. Expansion of livestock production will require more attention to the growing and utilization of forage crops as well as to production of the feed grains.

There has been only limited research in West Pakistan on range management. This needs to be upgraded and expanded to involve specialists in forage crops, soil and water management, animal husbandry, animal health, and agricultural economics. Such research could appropriately be a part of a regional international project for range management studies on problems common to West Pakistan, Afghanistan, Iran and Turkey.

Economic development, with rising personal incomes, tends to increase the demand for fruits and vegetables more rapidly than any other group of crops. Their production is usually on specialized farms and, in case of vegetables, near the cities. Success depends on effective grading, processing, marketing as well as on efficient production. Increased research on these problems will enable a higher proportion of the population to obtain such products and will permit a good return to fruit and vegetable growers for their operations.

As diversification increases there will be need for additional economic research at both the farm and market level. The more complex farm operations, with various crops competing for land, labor and other resources will require detailed studies to determine the most profitable combinations of enterprises. Production prospects will depend on available markets and continuing research is required to assess fully any future domestic and foreign outlets for alternative crops and livestock products.

Agricultural Engineering

Bullocks supply most of the power now used on Pakistan farms but tractor power is gaining in importance. The estimate for the number of serviceable tractors now on farms in West Pakistan is 14,000, averaging 35 delivered horsepower each. Increasing agricultural production will require greater power inputs, and double and triple cropping per year will require more exact timing of planting and harvest procedures. Crops must be removed quickly so the soil can be prepared properly for the next crop. This will require more power input per acre of land. New plant protection measures will be required with more intensive cropping, again requiring more power and more specialized machines.

The greater and more efficient use of fertilizers must be supported by equipment for accurate distribution at precise rates and depths for each crop and soil condition. There is a dearth of such equipment in Pakistan and research and development, including field testing under farm conditions, must be done by men with agricultural engineering competence.

Studies have shown that countries with low power inputs per acre of cultivated land are usually countries with low crop yields, when compared with countries with higher power inputs. Pakistan is among the lowest power input countries in the world. Estimates indicate that West Pakistan has .084 horsepower per acre presently available for crop production. No similar data are available for East Pakistan. Studies also indicate that about .2 horsepower per acre is the minimum needed to produce high yields of crops.*

It has been recommended that holdings of 25 acres and above could profitably turn increasingly to tractor power for additional inputs as production increases. Tractor power

*Towards More Powerful Agriculture — a report to the Governor of West Pakistan by G. W. Giles, consultant in Agricultural Engineering.

requires appropriate plows, tillage implements, seeders-cum-fertilizer spreaders, and harvestors. There are 367,487 farms in West Pakistan holding 25 acres or more with an average of 54 acres. The mechanization of any substantial number of these farms will require added trained manpower, not only to operate but also to service farm machines.

There are about 4.5 million farm holdings of less than 25 acres, averaging 6.3 acres where additional power will continue to be supplied largely by bullocks. Improved farm implements are needed also for such farms as they adopt new practices and to improve their efficiency.

Even though the farm holdings of East Pakistan average smaller in size than West Pakistan it is expected that mechanization of farm operations will increase. Additional irrigation by pumping is projected to supply more than one million acres with water during the dry season. This will establish double and triple cropping on these farms. A number of power tillers are under trial in East Pakistan to determine the makes most suitable for the Province.

Agricultural engineering technology is needed in the handling of many problems of irrigation and drainage. More accurate specifications should be available for irrigation pumping equipment for high water flow efficiency and minimum cost of operation. This research involves close collaboration of engineers with crop and soil scientists. Engineers trained for landshaping and for designing more efficient distribution systems for irrigation will be required in large numbers as more precise agriculture is practiced under new production technology.

Research on agricultural engineering problems is extremely deficient at all of the agricultural research institutes and at the agricultural universities. Such research should be handled as closely coordinated efforts in which soil scientists, crop production specialists, entomologists, and economists participate.

There is a dearth of agricultural engineers for manufacturing, design, development and research in Pakistan and few well trained agricultural engineers available for extension and education activities. Most of the engineers in the country are trained to deal with civil or industrial engineering problems and they have little experience and knowledge in the application of engineering principles to agriculture.

The Agricultural Universities should develop stronger departments of agricultural engineering with emphasis on power and machinery and on soil and water problems. Short courses and work shops should be offered in addition to degree courses.

Agricultural Economics

The rapid adoption of new technology, with the inputs of improved seeds, higher levels of fertilizer use, pesticides, assured irrigation, and machines changes the patterns of production on farms. Pakistan is experiencing this adjustment to commercial agriculture in wheat and rice production. Similar new technology and higher inputs will be utilized for other crops in the near future and the farmer will be confronted with several opportunities of increasing his production and income.

An important inducement for the adoption of new technology and improved management systems is a convincing demonstration, that change will result in an improvement in the economic well-being of the cultivator. Farm budgeting studies are needed to illustrate that more efficient agricultural production can be achieved by utilizing new and readily available technology and production inputs. These studies first must establish physical input-output relationships and then develop data on costs and returns of various enterprises and combinations of enterprises, utilizing different resource mixes.

Not only must guidance to farmers on production costs and returns be more precise, but also, government officials faced with questions relative to levels of price supports, subsidies, and other incentives must have more effective guidance based on economic research.

Development of the agricultural sector will create problems of production and distribution that have not been present in the previous, largely subsistence rural economy. Socio-economic research is essential not only for guiding the allocation of resources to reach the goals of self-sufficiency but also to anticipate, identify and develop tentative solutions to problems that will emerge once this goal is achieved.

Research in the natural sciences provides the data and knowledge needed for the introduction of new technology on the farm. And developed countries have found it advisable to have agricultural economists associated with natural scientists in planning and interpreting production research. The Team found very little of this in Pakistan, almost none at the research institutes. This deficiency should be corrected as soon as qualified staff are available.

It has been pointed out that the rapid achievement of self-sufficiency in food grains will bring about a sharp reduction in the P.L. 480 counterpart funds that now finance a substantial part of Pakistan's development program. The achievement of a marketable surplus of wheat and rice will present problems of foreign markets and an analysis of such markets will be needed. An alternative to exporting wheat would be a reduction in acreage and the production of other crops to diversify the agricultural sector. In any case, increased production and more production alternatives make it more essential to have good economic data on which to base national agricultural policy and plans.

The statistical base for the agriculture sector needs to be steadily improved. It will require the services of more economist-statisticians and a continuing research program.

There have been many foreign agricultural economists involved in selected research projects in Pakistan but little has been done to strengthen the institutional capability for either research or teaching in this important field. Although the agricultural universities are conducting research in connection with their graduate training programs, both problem selection and analysis are restricted by the lack of research funds. Furthermore, this research is characteristically descriptive rather than problem oriented. The Universities, therefore, should strengthen their teaching and research staff, engage in farm budgetary studies and cooperate in economic studies of special projects such as SCARP I and II.

As qualified personnel become available an economic research unit should be established with top quality leadership in the Agricultural Research Council as well as in the Ministry of Agriculture, East Pakistan. Agricultural economics research is a basic and integral part of the research problem areas previously reviewed in this chapter and it is increasingly important in a country undergoing such rapid agricultural growth.

Animal Production and Health

Economic development produces a combination of circumstances favourable to increased output and use of animal products so that commonly occurring protein gaps in human diets may be narrowed. Research should be directed to this end.

The principal sources of animal protein are milk, meat from cattle buffaloes, goats and sheep, poultry and fish. The potential for increased protein production from all of these sources is great but many of the present obstacles must be solved by expanding research on immediate critical problems.

Nutrition: Challenging opportunities for livestock improvement through improved nutrition exist in Pakistan. Research in this field is essential to improve growth rates, early maturity and breeding efficiency. The recent surge in increased production of cereals encourages the more extensive use of crop residues as components of poultry and dairy feeds. However, the effective feeding of these materials, with other available indigenous materials, must be worked out through research to determine their nutrient components which can be combined into balanced rations. Some investigations of this nature are underway at the veterinary research institutes but the efforts need to be expanded. Research in this area is particularly significant as it relates to the growing poultry and dairy feed industries. These commercial enterprises must coordinate feed formulations with regional requirements. Research is also needed to determine the feed efficiency of certain local fodders and rough grains that can be produced on marginal land, as well as on deficiency conditions such as trace elements, minerals and vitamins in particular regions.

Breeding: Although high producing, environmentally adaptable and disease resistant cattle, buffalo and cross-bred poultry have been identified, sufficient numbers of uniform individuals have not been selected and established as foundation stock for future breeding research programs.

The serious problems of irregular, inapparent ovulation in the buffalo has resulted in low productivity. If the buffalo is expected to compete more effectively with cattle, in breeding efficiency, research is needed to evaluate and improve its reproductive physiological characteristics.

The question of the desirability of upgrading livestock by indigenous selection or by introduction of high producing exotic species arises regularly. If investigations using imported breeds are to be carried out adequate base line herds of uniform indigenous stock must first be established, with breeding then confined to controlled herds in order that scientific measurements may be obtained. This work should, however, be carried out by competent geneticists in accordance with a carefully designed plan. Experimental work may be started by importing deep frozen semen rather than live animals.

Imported lines of poultry are particularly vulnerable to adverse climatic conditions and local diseases. Research is underway in Pakistan to establish useful breeds by crossing imported lines with highly resistant local breeds. Laboratory trials indicate success in improving growth rates and egg production but further trials are necessary to determine field adaptability.

Health: Many of the devastating diseases of animals in Pakistan have been controlled as a result of research on new or improved vaccines and other biologicals. However, a number of other diseases and parasites, for which effective control methods do not yet exist, still take a heavy toll. Several of these are currently under investigation by university or research institutes in Pakistan. Further research support is needed to develop more effective vaccines for Ranikhet disease, hemorrhagic septicemia and foot and mouth disease, and to find new methods for parasite control in all classes of animals.

The comparative influence of diseases and low nutritive status on fertility rates in livestock has not been elucidated. Before effective breeding programs can be established, these factors must be determined.

Management: A great deal of research should be focussed on management practices in livestock development. It is essential to know acceptable stocking rates under different conditions, the design of housing or pen construction, particularly for poultry, and the selection of the proper type of animals for specific environmental conditions.

Ducks are a hardy, disease resistant and highly adaptable class of poultry. Selected varieties under efficient management are good egg producers as well as good meat birds. Although duck eggs and duck meat are not extensively used research aimed at increased productivity and marketing practices could make a valuable contribution to increased protein availability. The expanded utilization of these products could be stimulated through effective extension service programs.

Sheep and goats, in addition to supplying significant amounts of meat and milk, provide hides and wool for export and local consumption. The indigenous breeds are highly adaptable but low in productivity. Research is necessary to improve the quality of wool and meat and to increase milk output in goats. Investigations using selected females and high quality males in a breeding program to improve wool quality are encouraging. This type of research effort is most applicable in West Pakistan but certain aspects also have potentials for East Pakistan.

Pond Fisheries: Under good management, fertilization and feeding, ponds can produce up to 5,000 pounds of fish per acre. But in Pakistan the usual cropping amounts to only 200 to 300 pounds per acre.

East Pakistan, particularly, has extensive resources for fish culture which should be exploited to provide increased quantities of protein for human use.

The limiting factors to effective pond fisheries production in Pakistan are lack of research on (1) control of aquatic weeds (2) fish diseases (3) fish cultural practices and (4) species adaptability. Current efforts are confined to the raising and voluntary distribution of fingerlings. Extension demonstrations of fish culture techniques and pond management have not been established and at this time no institution has undertaken training and research in this important field.

CHAPTER IV

IMPROVEMENT IN SUPPORT, PLANNING AND EXECUTION OF AGRICULTURAL RESEARCH

The Pakistan Agricultural Research Council

There is some uncertainty with respect to the responsibility for agriculture and the extent to which the Central Government should participate in this sector. The experience of recent years, with the strong personal interest of President Ayub Khan in the rapid development of agriculture, furnishes conclusive evidence of the importance of a significant leadership role from Central Government.

The availability of food, and of other essential agricultural products, is a matter of concern to all of the people of a nation. The joint attention to agricultural development by the Central Government and the Provinces is, therefore, essential. Problems must be approached from a position of cooperation and collaboration.

The need for close cooperation in agriculture is particularly essential in the field of research. The development and application of new knowledge to increase productivity in agriculture is a major factor in a solid base for economic and social progress. In developing nations, with limited trained scientists, limited finances, and limited laboratory and field station facilities, there is a special need to make maximum efficient use of these resources. Coordination of effort attains a special order of importance.

The Pakistan Agricultural Research Council is generally recognized as having a major responsibility for 'Coordination' of agricultural research throughout the country. This appears at this time to be a nominal responsibility rather than an actual one. The Council as it is now organized and as it now operates is not in a position to supply the important support and coordinating leadership for agricultural research so important at this stage of Pakistan's agricultural development.

The Team has reviewed the origin and history of the Council, its organization and staffing, and its difficulties and deficiencies, as a basis for recommending an improved organizational and operational structure for the Council.

The Pakistan Agricultural Research Council, the counterpart of the Indian Council for Agricultural Research, was established in 1951 as the Food & Agriculture Council of Pakistan. It was replaced by the present Agricultural Research Council in November 1964 on the recommendation of the Food and Agricultural Commission.

The Council consists of 27 members, with the Minister for Agriculture and Works as its Chairman and the Secretary, Ministry of Agriculture and Works as Vice-Chairman. It has been decided recently that the Provincial Ministers of Food and Agriculture should also be Vice-Chairmen of the Council. The members include representatives of the Ministry of Agriculture and Works, the Planning Division, Ministry of Finance, Provincial Agriculture Departments, universities, prominent scientists, progressive farmers, and Vice-Chancellors of the Agricultural Universities.

The Council derives its income from the Cesses collected under the following Central Acts:—

1. Agriculture Produce Cess Act, 1940.
2. Oilseeds Committee Act, 1946.
3. Coconut Committee Act, 1944.
4. Lac Cess Act, 1930.

The annual income is about Rs. 1.5 million.

The technical staff consists of two Directors of Research—one for Agriculture and one for Animal Husbandry. Each Director is assisted by one Assistant Director and one Technical Officer. In addition there is one Editor and one Sub-editor responsible for publications. The routine administration of the Council is handled by a Secretary, with the necessary clerical staff.

The Council works through five Technical Committees and one Policy, Liaison and Finance Committee. Hitherto the main activities of the Council have been confined to supplementing the funds of the Provincial/Central Government Departments and the universities, primarily for financing research schemes of short duration. They may be extended. The new program schemes are initiated by individuals from the various research institutes or universities and when forwarded to the Council they are first examined by the Directors of Research and the Technical Committees for their technical soundness. The recommendations of the Technical Committees are considered by the Policy, Liaison and Finance Committee, in which the chairmen of the Technical Committees are represented, and finally the schemes are approved or rejected by the Council. Schemes of an urgent nature are approved by the Chairman himself.

Major deficiencies of the present system are:—

1. Most of the schemes submitted to the Council are "projects" of narrow scope.
2. There is no over-all coordination of research since the Council is concerned only with those individual schemes which are proposed to it for financing. This precludes the effective assessment of broad problem areas and the design of modern multi-disciplinary research to resolve or eliminate such problems.
3. The procedures followed in sanctioning the schemes are excessively time-consuming and result in long delays in the implementation of the schemes. Financial sanctions required after a project is approved are especially time-consuming.
4. The schemes are of short duration and this presents a difficulty in finding and retaining scientific staff with the requisite qualifications and experience. The rapid turn-over of research personnel in Council-supported, temporary schemes hampers development of effective research results on agricultural problems which require continuing, long-range attention.

5. Funds of the Council are entirely inadequate for the scope of the research which should be undertaken, as outlined in Chapter III of this report.
6. The Council, as set up under the Agriculture Produce Cess Act of 1940, does not have sufficient flexibility to function effectively.
7. Many members of the Council are non-technical and the number is larger than is desirable for efficient functioning of a Council.
8. The technical staff of the Council is inadequate to cope with the work effectively and the absence of a technical head of the Council is a handicap in the proper functioning of the Council as a scientific body.
9. There is no arrangement for the systematic collection of research information in the country and abroad and supplying it to the research workers concerned.
10. There is inadequate provision for bringing scientists together and providing them opportunities to discussion and exchange of ideas through symposium, seminars, or conferences.

The Team recognizes that substantial change is required in the organization, functions, and procedures of the Council, with the following basic provisions:—

1. The Council should serve as the principal technical arm of the Ministry of Agriculture and Works, in strengthening agricultural science and technology in the country and in keeping the Ministry abreast of research developments in Pakistan and abroad.
2. The Council should have an active, positive role in identifying problems confronting Pakistan agriculture and in planning, with appropriate research organizations of the Provinces, the agricultural universities, and other organizations, cooperative and coordinated research projects for the solution of such problems.
3. The Council should have a cadre of well qualified scientists who would participate in research schemes, and in case of research of broad regional or national significance, may serve as coordinating leaders of the projects. The development of the Council cadre and the system of selection and promotion on merit is discussed further in Chapter V.
4. The Council should work primarily with, and through, the existing research institutes, universities and other organizations, but should be authorized to establish special research institutes or directorates for particularly important problem fields of nationwide scope if this becomes necessary.
5. The Council should be a technical body consisting primarily of leading scientists in the respective disciplines relating to agriculture. The membership of the Council, to assure an effective working body, should be limited.
6. The arrangement for the Minister of the Ministry of Agriculture and Works to serve as Chairman and the Secretary, Ministry of Agriculture and Works and Provincial Ministers to serve as Vice-Chairmen may be continued.

7. There should be a Director General of the Council who is an eminent scientist in Agriculture or Animal Husbandry.¹

8. The Council should have an adequate scientific staff at the Director level to furnish capable leadership in research evaluation, planning and coordination in the major fields of agricultural research and development including (a) Crop Husbandry, (b) Animal Husbandry, (c) Soils, Irrigation and Engineering, (d) Agricultural Economics and Statistics, (e) Forestry and Range Management, and (f) Fisheries. Supporting staff should be provided to deal with various specific problem areas within each field.

9. The Technical Committees should be reconstituted, with newly selected advisory committees established, as needed, composed of competent scientists from both wings and the Central Government, for the special problem fields of crop husbandry, animal husbandry, forestry, fisheries, etc.

10. The Council should have adequate, effective financing. The support to the Council should be increased to a level of Rs. 20 million per year and increased further as the needs of the research program and related activities of the Council may require.

11. The Central Cotton Committee and the Central Jute Committee should work in close collaboration with the Agricultural Research Council. Further discussion of coordinated research for improving cotton production is presented in Chapter VI.

The proposed organization, objectives, functions and membership of the Council are presented in detail in *Appendix VI*.

In view of the continued shortage of well qualified technical personnel in Pakistan, it would be well to fill certain posts in the Council on an acting or temporary basis, until qualified people are available.

RECOMMENDATION 1. The Pakistan Agricultural Research Council should be organized in the pattern of the Pakistan Council of Scientific and Industrial Research to provide for more flexibility in planning, support, coordination and conduct of research in the many complex problems in the nation's agriculture. The proposed objectives and organizational structure of the Council are shown in *Appendix VI*.

In Chapter VII it is recommended that a Board of International Agricultural Science Consultants be established for continuing assessment of progress in developing Pakistan's improved research organization and programs. It would be desirable to have one member of this Board to serve as its Executive Secretary, available on a full-time basis in Pakistan to consult with appropriate government officials and research personnel in the organization and functions of the Council. This person should, of course, be a scientist of repute with experience in planning, organization and conduct of inter-disciplinary, regional or national research programs.

1) The success of the Council will depend in large measure on the ability, status and powers of the Director General. The American members of the Team, therefore, recommend that the Director General have the status and powers of a Secretary of Government of Pakistan or Vice-Chancellor of a University.

East Pakistan Agricultural Research

In view of the low status of agricultural research in East Pakistan, special and urgent attention is needed to strengthen research institutions. The Agricultural Research Institute, Dacca, is being shifted to its new site at Joydebpur. Due to delays in development of physical facilities at the new site, the progress of research has been seriously hampered. This has also led some capable staff to transfer to other agencies where working conditions are more favourable.

It is necessary to expedite the provision of physical facilities, staff and funds comparable to similar research institutions in West Pakistan such as the Ayub Agricultural Research Institute, Lyallpur. In addition to the funds provided in the current Plan for the Institute at Joydebpur the Agricultural Research Council should make substantial grants so that the Institute is capable to function at an effective level. The Council may also consider the location at this Institute of Special Research unit with adequate staff, funds and facilities for work on problems requiring intensive team work. It cannot be too strongly emphasized that without a well developed Provincial agricultural research institute, agricultural progress and development will continue to be seriously hampered.

The Ford Foundation is assisting in financing the development of a Rice Research Institute at the new site of the East Pakistan Agricultural Research Institute and College. The plans and programs have been developed by the International Rice Research Institute and the Department of Agriculture. Facilities should be completed within a year as usual procedures have been set aside. The Rice Research Institute and the Accelerated Rice Research Scheme merit high priority. It may be desirable to provide special conditions for operations as well as for construction of the physical facilities.

The Reconnaissance Soil Survey of East Pakistan, a Central Government Scheme, is making good progress and providing useful data particularly for development areas. The Rapid Soil Fertility Scheme of the Province has developed information on fertilizer requirements and use, but related laboratory investigations are quite inadequate. Likewise liaison with extension and industrial development needs to be improved.

The East Pakistan Agricultural University, as will be indicated in Chapter IX, has good research potential in terms of staff and facilities. It should be utilized to help compensate for the existing deficiencies of the Agricultural Research Institute until its new facilities are developed. Subsequently the two organizations should continue to cooperate on many projects.

The Agriculture Division of the Dacca Atomic Energy Commission Laboratory is well staffed, has good facilities and provides a good environment for research. Plans provide for its transfer to the Agricultural University under cooperative arrangements that should be mutually beneficial to both agencies and also to graduate students.

RECOMMENDATION 2. In view of the deficient status of agricultural research in the Province, the urgent need for improved facilities, staff and progress, the Team recommends the establishment of a Special Committee of the A. R. C. to advise in the planning, implementation, coordination, and evaluation of agricultural research in the Province.

Action should be taken on the following:

- (a) a study of research administration by a competent, experienced person, to advise on measures to increase efficiency,
- (b) a greater role in administration for scientists,
- (c) delegation of more authority at several levels on administration, and
- (d) increased incentive for staff by making selection and promotion on the basis of merit.

Cooperation and coordination between different institutions and organizations would be greatly increased by the formation of an organization that would bring together scientists concerned with agricultural research.

RECOMMENDATION 3. Department of Agriculture, East Pakistan should explore the possibility of organizing an East Pakistan Agricultural Research Association or Society which must be composed of institutions engaged in agricultural research including selected non-governmental institutions, to facilitate a periodic and regular review of programs and problems of mutual concern.

West Pakistan Agricultural Research

Most of the agriculture research in West Pakistan is under the Provincial Department of Agriculture. It is operated largely by the Regional Institutes at Peshawar, Lyallpur and Tandojam. Other agricultural organizations for research, education and extension are also located at Peshawar, Lyallpur, Tandojam and Lahore as indicated below:—

Peshawar

1. Tarnab Agricultural Research Institute, 12 miles from the University. Plans are being considered to move to a site adjacent to the Agricultural College.
2. Agricultural College, Peshawar University.
3. Forestry Research Institute, adjacent to the University.
4. Regional Agricultural Extension Headquarters, adjacent to the University.
5. Veterinary Research Institute.

Lyallpur

1. Ayub Agricultural Research Institute.
2. West Pakistan Agricultural University.
3. Agricultural Division, Atomic Energy Laboratory.

Tandojam

1. Agricultural Research Institute.
2. Agricultural College, Sind University.
3. Agricultural Laboratory, Atomic Energy Commission.
4. Regional Agricultural Extension Headquarters, Hyderabad.

Lahore

1. West Pakistan, Department of Agriculture.
2. Veterinary Research Institute.
3. Animal Husbandry College.
4. Regional Agricultural Extension Headquarters.

The Team's observations on research progress, staff development and other matters were based in large measure on our visits to the foregoing institutions and are presented in other chapters of the report. There are some special opportunities for mutually beneficial cooperation in West Pakistan which should be considered.

The Heads of the institutions at each location should explore the possibility of cooperation in research planning, operations, staff development, and related matters.

RECOMMENDATION 4. The heads of the institutions concerned with research at each location in the Province should develop a Memorandum of Cooperation, to go to the Secretary of Agriculture for approval, which would provide the formal basis for cooperative work. The Memorandum should be amended from time to time as the fields of cooperation increase or change.

The proposal should include provision for the following activities and arrangements:

- (a) joint research projects,
- (b) cooperative use of special facilities or resources,
- (c) faculty appointments for senior institute staff and assignment of graduate students to them for thesis work,
- (d) post-graduate training at the university or college for junior members of research institutes and extension staff, and
- (e) sharing the use of library facilities.

Cooperation and coordination of research between the three regions will be increased by the development of coordinated research schemes. They serve to bring together scientists concerned with a single problem. There appears to be a need for an organization that would afford the Directors of all agricultural research institutions in the Province a regular forum for consideration of matters of common interest.

RECOMMENDATION 5. The Department of Agriculture should explore the possibility of organizing a West Pakistan Agricultural Research Association or Society, with membership composed of institutions engaged in agricultural research, including selected non-governmental institutions, to facilitate the periodic and regular review of programs and problems of mutual concern.

RECOMMENDATION 6. Vigorous action should be taken by appropriate officials of the Government of West Pakistan to correct the procedures for planning and implementation of research, including the arrangements for financial sanctions, and such other factors which limit the effectiveness of research in the Province.

Action should be taken on the following points:—

- (a) a study of research administration by a competent, experienced person, to advise on measures to increase efficiency,
- (b) a greater role in administration for scientists,
- (c) delegation of more authority at several levels of administration, and
- (d) increased incentives for staff by making selections and promotion on the basis of merit.

Financial Support

The Joint Team did not have an opportunity for a detailed review of financial support for agricultural research. The evidence of inadequacy of such support was clear from the visits to the various institutions and from the problem areas now receiving insufficient attention, some of which are reviewed in Chapter III.

The present support for agricultural research, as detailed in the Third Five Year Plan for the Provinces and the Central Government, is as follows:

	Millions of Rupees
East Pakistan	28.1
West Pakistan	32.4
Centre (including jute research)	31.8
Total	92.3

In addition, the Pakistan Central Cotton Committee expends about Rs. 2.5 million and A. R. C. about Rs. 1.5 million on research. The total expenditure on agricultural research thus comes to about Rs. 23 million per annum.

The comparative expenditures for the Pakistan Council for Scientific and Industrial Research (PCSIR) and the Atomic Energy Commission (AEC) are Rs. 12 million and Rs. 11.2 million per annum respectively.

It is of course difficult to determine the effective funds for research since funds budgeted for research may be delayed in actual use or application because of the administration and financial sanction procedures. The Team is aware of this problem but has no specific proposals except that this is a matter which should be given attention.

The Team has proposed that the budget for the Agricultural Research Council, when it is reorganized and strengthened, should be at the level of Rs. 20 million annually. These funds, and additional funds for the Council and Provincial research institutions should be made available as effective research programs—preferably on the inter-disciplinary and coordinated pattern—and as other requirements are justified.

RECOMMENDATION 7. The opportunities for substantial returns from additional investments in research are most promising in a wide range of problem areas. Appropriate government officials and leaders of research organizations should make a strong mutual effort to explore and fund such opportunities.

CHAPTER V

INCENTIVES FOR PROFESSIONAL CAREERS IN AGRICULTURE

It is estimated that about 80 per cent of Pakistan's population of 112 million live on farms or in rural areas. Yet agriculture has a low status among the professions in the country. This is clearly evident from a comparison of salary scales for those in agriculture with those in administrative posts or other professions. The extension worker who carries new advice to the farmer is near the bottom of the pay scale in the public service.

Unless careers in agriculture are made more attractive this field will not draw the best minds among young men entering the colleges and universities. Pakistan cannot afford to have mediocre leadership in developing new knowledge to guide its agricultural development.

Vigorous growth is occurring in food grain production and self-sufficiency is in prospect in rice and wheat in the next few years. There are suggestions that Pakistan agricultural technology may be exported or be made available to help other nations in the years ahead.

In this connection it is important to maintain an objective view of the factors that are bringing about the present growth in food grain production. As stated in Chapter III, the packages of new technology for wheat production and for rice production were introduced from Mexico and from the International Rice Research Institute. Pakistan is not yet abreast of the adaptive research to guide the effective and efficient use of the IRRI rice in East Pakistan, and the wheat improvement scheme is in need of strengthening to make it a well coordinated, inter-disciplinary effort with the autonomy and flexibility required to move vigorously against potentially serious disease hazards and other problems.

Agricultural research and the related developmental services furnish an extremely challenging future for young men. With a rate of population increase that has been estimated at between 2.5 to 3.0 per cent annually, there is need for a continuing flow of new productivity—increasing inputs in the nation's agriculture in the years ahead. And few achievements can be more satisfying than for a young scientist to know that he has contributed significantly in helping his country feed its people.

There are a number of disincentives or factors which limit attractiveness of agricultural research as a profession and which demand special corrective attention.

Salary Levels

The low rate of pay and lack of comparability with other fields and services have been mentioned earlier. The following table shows the salary scales in agricultural research as compared with those of scientific posts in the Council for Scientific and Industrial Research and in the Atomic Energy Research Commission:

The above disparities in pay scales, particularly the greater opportunities above the Senior Research Officer or Specialist post, have caused a number of the more able young

COMPARATIVE PAY SCALES (RS. PER MONTH) OF PROFESSIONAL PERSONNEL

Organization	Research Directors	Head of Divn. or Chief Scien. Officer	Principal Scientific Officer	Senior Res. Officer or Specialist	Research Officer	Asst. Res. Officer	Research Technical Assistant
P.C.S.I.R. & P.A.E.C.	2000— 2000	1600— 2000	1250— 1800	750— 1500	450— 1000	350— 925	285— 650
Department of Agriculture Govt. of East Pakistan	1600— 1800	—	—	450— 1250 ²	—	350— 925 ³	275— 650
Department of Agriculture Govt. of West Pakistan	1600— 1700	—	—	750— 1500	—	350— 925	275— 500
Central Government Departments ¹	(a) 1125— 1500 ⁴ (b) 1600— 1700 (c) 1800—2000	—	—	750— 1500	450— 1000	350— 925	220— 450 285— 650

¹ Such as plant protection, fisheries, etc.

² Plus technical pay, Rs. 100.

³ Plus technical pay, Rs. 50.

⁴ Plus special pay, Rs. 100.

agricultural scientists to transfer to positions in the P.C.S. & I.R. and A.E.C. Capability in agricultural research is as important as in these other fields and the lower pay scales would seem difficult to justify.

In addition to the salary discrepancies with the other research organizations there are some differences between the Central Government and the two Provinces. Agricultural universities have freedom to establish pay scales and this contributes further to the ranges in salaries and competition for agricultural specialists.

As a result of the lack of uniform salary scales there is a most undesirable practice of trained personnel shifting from one discipline to another as posts at slightly higher salaries open up. This precludes the continuous professional experience in a special field which permits an individual to develop the depth of understanding which leads to a position of respect among his scientific colleagues. More important still, such a person is not usually capable of serving effectively in advising government on the application and use of new technology.

The economic botanist who works for several years on wheat, then shifts to a position in rice improvement, and later to potato research or to some other crop is a transient practitioner who neither develops a satisfactory career nor contributes significantly to the new science and technology so urgently needed in Pakistan. This fracturing of a career into segments of short time duration is a decided handicap in carrying out effective agricultural research in the country and the fault rests with the system of position classification and promotion.

Selection and Promotion Procedures

There is considerable endorsement by administrative officers of the principle of promotion on the basis of capability and performance (merit) but there is limited evidence that this is practiced. The development of a research personnel management system which will permit appointments and promotions on the basis of merit is urgently needed if Pakistan agricultural science is to contribute effectively to economic growth and development.

The Agricultural Research Service of the U. S. Department of Agriculture has established a *Research-Grade Evaluation Plan*, based on "the man in the job" concept of classification. The basic premise is that a scientist's research ability will, to a great extent, determine his output and should, therefore, be taken into account in determining the grade and salary level at which the position functions.

The U. S. Department of Agriculture system provides that all appointments and promotions at the middle and higher grades of service be evaluated by a Committee of scientists in the respective discipline to insure objective evaluation of the capability or merit of the individual for the post.

It is not uncommon for a scientist in the USDA Agricultural Research Service to occupy a grade and salary above that of his administrative supervisor. One particularly competent soil scientist, a few years ago, was paid more than the Administrator of the Agricultural Research Service.

The Research-Grade Evaluation Plan of the Agricultural Research Service is explained in the publications in *Appendix VII*. While it will undoubtedly not be possible, or advisable, to adopt in total the procedures or system as followed in the United States, the principles involved are directly applicable and should be studied to determine how a merit promotion system with uniform pay scales can be established for agricultural specialists in Pakistan.

The procedures followed for recruitment and advancement of scientific personnel in P.C.S. & I.R. and the A.E.C. also should be studied for possible application in agriculture.

RECOMMENDATION 8. The development of a uniform schedule of salaries and improved selection and promotion procedures based on merit should be undertaken by the Pakistan Agricultural Research Council in collaboration with appropriate representatives of the two Provincial Governments. The assistance of a consultant from the Personnel Division of the USDA Agricultural Research Service would be most useful in this effort.

The objective should be not only to establish a merit-promotion system but also to develop a cadre of A.R.C. staff and Provincial agricultural research staff which would be fully interchangeable. The salaries in the agricultural universities are now somewhat more flexible and could be adjusted to the government service scales as necessary in order to remain competitive.

Seniority

The emphasis on seniority in considering promotions or in filling new positions of leadership has a detrimental effect on the present quality of agricultural research in Pakistan. This will become even more serious as modern science and technology is applied in further interdisciplinary projects or schemes to increase agricultural productivity.

The length of experience in a specialized field is important in gaining depth of knowledge and capability. But age supplies no index of ingenuity and imaginative leadership, or of willingness to collaborate with scientific colleagues in related fields. In fact there is too frequent evidence in Pakistan of the lack of flexibility in accepting new team-work approaches and of lack of willingness to accept as co-equals the younger and more recently trained scientists.

While seniority should not be given undue emphasis in filling posts or in promotions, neither should it be the cause of undue discrimination in limiting senior personnel for key posts in coordinated research schemes. Those senior scientists, up to 50 years of age, who have potentially productive years of service ahead of them should be given study tours abroad and opportunities to participate in international scientific conferences in order to maintain an up-to-dateness in their field of specialization. Such opportunities should, of course, be on a highly selective *merit* basis.

Research Administrators

Leadership in planning, coordination, and general administration of agricultural research should be in the hands of agricultural scientists. No country in the world has achieved significant progress in science and technology without having the program leadership and financial *responsibility* for research fully in the hands of scientists who understand

experimental methods, who appreciate the need for full exploitation of ideas, and who exercise maximum flexibility in utilization and allocation of resources.

As more research is conducted as cooperative inter-disciplinary efforts, with different institutions or organizations participating, the need for scientists with training in organizational and management of research will be increased.

There is at the present time an inadequate number of trained and experienced "science administrators" in Pakistan.

RECOMMENDATION 9. Special steps should be taken by the Agricultural Research Council to support tours abroad for Pakistan scientists to study organization and administration of research, and also to establish special courses in agricultural research administration in the National Institutes for Public Administration.

CHAPTER VI

RESEARCH COORDINATION

The coordination of research involves primarily the orderly interchange of information and materials between scientists in different disciplines and in different institutions.

There is, of course, need for a depth of interest by a scientist in his given field of research or discipline such as entomology, genetics, engineering, veterinary science, etc. This strong discipline orientation exists especially in the universities where teaching programs are tied to such subject matter fields. But effective research on complex agricultural problems requires a blending of scientific talents, and full collaboration by scientists with their special competencies.

In addition to achieving the exchange of ideas and materials between individual research workers in different fields there are problems in establishing linkages between institutions. A third problem in coordination relates to focussing the joint attention of individual scientists and research institutes on problems of mutual concern in agricultural development.

The difficulties in coordination in research are never completely resolved and a certain degree of scientific or institutional individualism persists even in the more advanced nations. Lack of cooperation and coordination in agricultural research is a serious handicap in Pakistan and measures for improvement are urgently needed.

Coordination by the Administrative and Budgetary Process

It is commonly assumed that coordination can be achieved through administrative officers who request frequent reports on objectives, plans, and progress of research. Similarly the control of budgets is frequently used in attempting to direct or influence research workers to collaborate.

These measures do not achieve *effective* coordination. The domination of research work by administrative procedures may achieve *compliance with regulations* but usually results in stifling initiative and in restricting output in research. The requirement for excessive reporting, on a monthly or quarterly basis, diverts the time of research workers which might better be employed in the pursuit of their experiments. In very few research problem areas in agriculture can reports of progress be justified more than once a year.

Research Institutes

The Team has found a strong tendency among agricultural scientists in Pakistan to propose new research institutes to cover problems not now receiving adequate research attention. This appears to reflect a desire to develop self-contained packages of research in institutes that may be dominated by the leadership of one director.

The institute type of organization is effective in combining the efforts of scientists from different disciplines. Frequently such institutes are established to concentrate on basic or fundamental research in selected problem fields and commodity research institutes have

been functioning for many years in different countries. The British established such institutes on sugar cane, rice, oilseeds, potatoes and other crops in India as well as on rubber and cocoa in Africa. The Hawaiian Sugar Planters Association and the Pineapple Research Institute in Hawaii have a long record of productive research on these crops.

In the United States special laboratories were established by the U. S. Department of Agriculture in the 1930's to work on soybeans, pasture crops, vegetables, poultry, soil salinity, plant and animal nutrition, and in other similar fields.

The most prominent specialized institute serving international agriculture is the International Rice Research Institute at Los Banos, the Phillippines. This is a most effective center for combining scientific disciplines in improvement of the rice crop.

While the research institutes or directorates are usually effective in associating attention of specialists from different fields on a given problem, in many cases they lack linkage with other research or operational organizations concerned with agriculture and they may tend to become isolated from the practical problems of the region. This is particularly true of those central research institutes which are concerned primarily with fundamental research and make little direct impact on agricultural development.

Coordinated Research Projects or Schemes

Coordinated research projects which are concentrated on the improvement of production of a given crop or commodity, or on the solution of more general agronomic, soils, engineering, or livestock production problems, are most effective in combining the scientific as well as broad institutional participation. There has been a long history of experience with such coordinated research schemes, including projects in the United States which extend back for more than 40 years.

One of the best examples of progress achieved through coordinated research is the development of hybrid maize in the United States. For more than 30 years, beginning in about 1890, many outstanding geneticists, working independently in federal research laboratories, at the agricultural colleges or in specialized private research centers, made interesting discoveries with respect to hybrid vigor in the inbreeding and crossbreeding of maize. Those findings, however, were individual and disjointed.

In 1923, a cooperative project for maize breeding and improvement was established by the U.S. Department of Agriculture and the state agricultural experiment stations of the Land Grant Colleges. Coordinating leadership was supplied by the USDA, together with a number of scientists who participated actively in the research, located at the experiment stations in the region. Ten years later, as a result of the combined efforts of the plant breeders and geneticists of the cooperating stations throughout the central maize growing area of the United States, adapted hybrids suited for growing over most of this major "corn belt" were available.

Wheat improvement research was initiated in a similar collaborated effort by the U.S. Department of Agriculture and the States in 1930, followed by cooperative projects on other crops and on other agricultural problems.

The above crop improvement projects were primarily concerned with plant breeding, with some joint attention from plant pathologists. The more comprehensive inter-disciplinary coordinated research, involving soil scientists and other specialists, emerged about a decade later. The combined attention of such specialists to the improvement of corn production in the Southern U. S., in a program initiated by the U.S. Department of Agriculture and the North Carolina Agricultural Experiment Station in the early 1940's, was a major factor in the rapid expansion of reliable new corn growing practices throughout the region. This program, in which many states participated, gave attention to (1) selection of adapted hybrids, (2) optimum plant populations per acre, (3) the most effective levels of fertilizer application, and (4) improved planting, tillage and weed control methods.

The Rockefeller Foundation's cooperative international research program for the improvement of the major food crops including wheat, maize, sorghums and millets was established in 1943 along the same pattern.

The coordinated scheme approach has been used in the research supported by the U.S. Agency for International Development for regional studies on Cereal Crop Improvement in Africa, on Improving Grain Legumes in South Asia, and on the Control of Weeds in Latin America. These projects have been under way for only five years or less but they have demonstrated the value of this cooperative approach as have the earlier experience of the Rockefeller Foundation and the USDA-State experiment station activities in the United States.

Some of the organizational and operational features of the coordinated scheme or project approach are outlined in *Appendix VIII*.

The cooperative wheat improvement program in West Pakistan, in which the Ford Foundation is cooperating and for which Dr. Ignacio Narvaez is serving as the adviser, is still being developed as a coordinated research scheme. At the present time this program involves primarily plant breeders, with the collaboration of some plant pathologists. There is need for better linkage with the other disciplines, including soil scientists, irrigation specialists and agricultural economists.

There is need also for greater flexibility in this project to facilitate working with the several regional research institutes, the West Pakistan Agricultural University, and the College of Agriculture personnel of the University of Peshawar. A number of competent staff members of these institutions can contribute, through special studies, to the total project. It is because of this inter-institutional linkage, with cooperative experiments throughout the region that the coordinated research scheme, as now initiated, should be strengthened.

An essential feature of inter-disciplinary cooperative research in which a number of institutions participate is the ability of the individual and the organization which is responsible for the coordinating leadership to carry out this function without excessive domination and control. Scientists from the participating disciplines must all be of high capability, and they should have a voice in planning the program as well as in evaluating results. In truly cooperative efforts the objectives and procedures are developed in annual planning conferences, the scientists have a clear concept of their respective roles, and the heads or directors of

the cooperating institutions understand the need for support and flexibility of travel of their staff to insure a successful joint effort.

RECOMMENDATION 10. The accelerated programs for increasing production of wheat and rice must have more effective backstopping from research to insure reliable guidance in adapting the introduced technology to Pakistan conditions and to furnish prompt attention to uncertain pest and disease hazards. Special attention must be given to the support of these projects for rapid development of essential research facilities, for provision of qualified staff, and for the flexibility in cooperative arrangements that will insure maximum progress in supplying a more adequate research base for these important food grain production programs.

The wheat improvement project is proving the effectiveness of the coordinated research scheme approach in this country and the need for special research attention for the accelerated wheat and rice programs is discussed in Chapter III. Similar cooperative efforts should be developed for other crops including maize, sorghum, millets, oilseeds and other commodities.

Special attention should be given to the development of a coordinated research scheme for the improved production of cotton, an important crop in which insufficient progress in achieving high productivity has been made. This was discussed earlier in this report, in connection with the Pakistan Agricultural Research Council under Chapter IV.

The team is aware of the data of the Central Cotton Committee which indicate an increase in average annual yield of lint per acre from 188 pounds in the 1950-55 period, to 225 pounds in the 1960-65 period. However, the data from the Agricultural Research Institute at Tandojam, in their report entitled Agricultural Research in Southern Zone of West Pakistan of January 26, 1967, show little real increase in yields since 1950-51. The data for area, production, and yield per acre in the Southern Zone since 1950-51 are as follows:—

Year	Area (Acres)	Production, bales of 392 lbs. each	Yield, lbs. of lint per Acre
1950-51	8,64,386	4,68,436	212
1951-52	9,06,329	4,68,049	202
1952-53	9,98,731	6,41,461	252
1953-54	9,01,352	5,32,212	231
1954-55	9,01,888	5,24,834	228
1955-56	9,92,628	5,26,886	208
1956-57	10,17,428	5,35,488	206
1957-58	10,68,403	5,87,315	215
1958-59	9,37,597	5,68,588	238
1959-60	10,08,000	5,08,000	197
1960-61	10,49,000	5,76,000	215
1961-62	10,42,000	5,21,000	205
1962-63	9,84,000	5,61,000	223
1963-64	10,07,000	5,98,000	237
1964-65	8,36,000	4,46,000	209
1965-66	9,17,300	7,01,200	313

RECOMMENDATION 11. A coordinated research program for improvement of cotton production, with combined attention to breeding of improved varieties, control of pests and diseases, and to soil fertility and water management, should be planned and carried out by the Central Cotton Committee in cooperation with the Agricultural Research Council and other appropriate organizations.

Patterns for Pakistan

In reviewing the research facilities and organizations in Pakistan it would seem desirable to limit the establishment of new special institutes to only a few critical problem areas such as the research on plant protection and pesticides, including the health hazards involved in the use of agricultural chemicals. This work should be conducted in close collaboration also with appropriate medical and health officers. The special institutes should be established at the existing research institutes or agricultural universities wherever possible to insure maximum efficiency in use of personnel, laboratory and field facilities, and libraries.

It should be possible in most cases to combine the research of a special institute with a coordinated research scheme, to provide for participation by scientists from various disciplines who are located at the several regional research institutes and universities or colleges. The joint planning of research to determine delegation of responsibility for specific aspects of the coordinated effort, with annual meetings to review progress and future plans is, of course, essential for a mutually satisfactory joint research scheme.

Support for coordinated research projects might be supplied by the Agricultural Research Council or by the Province, or jointly. The Agricultural Research Council should take part in planning and in review of progress of coordinated schemes. The Council should provide support not only as funds but also through the assignment of scientific personnel at selected research institutes of the Province or in the universities. Such staff members may serve in some cases as project coordinators, or as research workers carrying out specific parts of the program.

RECOMMENDATION 12. Coordinated research programs should be developed by the appropriate research organizations for selected problem areas discussed in Chapter III, including, (1) soil fertility, (2) water use, (3) crop protection, and (4) farm power and mechanization.

Developing a National System of Institutionalized Science

The principal element of strength in agricultural research in the United States, which was effective in developing a highly productive and efficient agriculture, was the evolution of a highly integrated and "institutionalized" agricultural science, through which the close collaboration of research workers in the U. S. Department of Agriculture, the state agricultural experiment stations and, more recently, research workers of private industry have resolved a continuing series of problems that inhibit agricultural development. This cooperation involved not only individuals but institutions which have learned to work together in their strong mutual concern for the solution of the nation's agricultural problems.

Pakistan's agricultural research must move from the present rather highly specialized, and personalized, narrowly defined studies to more collaboration among individuals and institutions. This is essential if sustained input of new knowledge and new technology for the continuous growth of Pakistan agriculture is to be made available.

CHAPTER VII

LINKAGE WITH INTERNATIONAL SCIENCE AND TECHNOLOGY

Rapid progress in agricultural science and technology is occurring throughout the world, not only in those countries with highly developed agriculture but also in some of the developing nations. In recent years special institutes have been established for research especially designed to promote international agricultural development.

Pakistan is now reaping the benefit of the cooperative wheat improvement research of the Government of Mexico and the Rockefeller Foundation, and of the rice improvement research of the International Rice Research Institute. The adoption of the new technology from these centres was prompted largely by the emergency conditions with respect to deficits in food grain production in Pakistan.

Procedures should be developed for continuous contact with international agricultural research so that potentially productive innovations can be constantly exchanged and put to practice as promptly as possible.

Participation in International Agricultural Research Schemes

The collaboration in wheat and rice improvement research with the centres in Mexico and the Philippines furnishes a pattern for similar collaboration in other important agricultural problem fields. In order to accelerate improvement of the rough grains—including maize, sorghums and millets—cooperative projects are being established with support of the Rockefeller foundation research programs and the Ford Foundation. This is a most progressive move which warrants full support of all cooperating organizations.

Rapid improvement of high protein foods can be achieved through participation in the regional research project supported by AID for the Improvement of Grain Legumes, with headquarters in Iran. The development of a similar cooperative research project on improvement of forage crops and range lands has been mentioned in Chapter III as a field of common interest to Pakistan, Afghanistan, Iran, and Turkey. This type of international collaboration will make maximum use of competence in other countries and will help to keep Pakistani scientists alert to progress elsewhere.

Fertilizers are so important in Pakistan that measures should be taken to establish and maintain international contacts in Europe, North America and Japan. The Nation Fertilizer Development Center of the Tennessee Valley Authority is a particularly good organization in this field. In recent years TVA has extended its studies and training facilities to many developing countries.

International Conferences and Study Tours Abroad

With the rapid progress in agricultural research throughout the world the usual procedures for exchange of publications result in a time lag of several months to a year or more in the acquiring of new information. International meetings to discuss advances in special problem fields serve an extremely important function in the interchange of new

advances in technology. The conferences sponsored by the International Rice Research Institute on diseases, plant nutrition, mechanization, and other fields have been most effective in keeping scientists concerned with rice improvement up to date on the latest findings.

The greater participation of competent Pakistan agricultural scientists in such international conferences should be encouraged. Also, study tours of a few months to one year in duration, to provide for observations in depth of research projects and the organization and administration of research in other countries are increasingly important.

RECOMMENDATION 13. The Agricultural Research Council should furnish support and take positive leadership in stimulating the attendance of agricultural scientists at international conferences and in arranging for appropriate study tours to keep Pakistan scientists in contact with research advances abroad.

Documentation and Library Services

In addition to the personal contacts through conferences and study tours, improvement in international communications should be brought about through the development of improved systems for exchange of scientific journals and other publications. The Agricultural Research Council should review the possibility of establishing a national documentation center with effective linkages to the principal agricultural research institutes overseas, and for arrangements within Pakistan for the prompt interchange of publications, microfilm, etc.

RECOMMENDATION 14. A representative of the U.S. Department of Agriculture Library, which has established an extensive national and regional computerized documentation system should be obtained as a consultant to assist in developing a national documentation system for agricultural research and related subjects.

Plant Introduction, Evaluation and Maintenance

The strong emphasis on crop improvement research particularly in the last two decades when there has been special attention to increasing production of the major food grains in the world has resulted in the development of valuable collections of germ plasm of these major crops. The U.S. Department of Agriculture has more than 15,000 varieties or lines of wheat and similar large collections of other economic crop plants.

The collection of maize lines developed through the U.S. National Academy of Sciences—National Research Council Project in the late 1940's includes more than 12,000 lines of corn which are in special germ plasm banks in the United States, Mexico, Colombia and Brazil.

The Rockefeller Foundation has an extensive collection of sorghums and millets in its germ plasm pool and the International Rice Institute has an excellent collection of the most important genetic lines of rice. A germ plasm pool of the outstanding grain legume varieties has been established in Iran.

Pakistan does not have a well organized system for plant introduction, evaluation and maintenance. Some introductions are made each year but usually on a limited and *ad hoc*

basis. The Team is aware of the introductions made by the Ayub Agricultural Research Institute at Lyallpur but this and other similar scattered activities in Pakistan do not take full advantage of the potentialities from introducing new crop germ plasm.

A system should be evolved for the orderly introduction and testing of the world crop germ plasm resources. Attention is needed also towards the development of more effective plant quarantine procedures, to guard against the introduction of destructive crop pests and diseases.

In the past 20 years the U.S. Department of Agriculture and the State Agricultural Experiment Stations have strengthened the program of plant introduction, testing and maintenance in the United States. A National Seed Storage Laboratory at Colorado State University and regional crop testing and maintenance centers in the principal agricultural regions of the country provide for an effective system for handling all types of crop plants.

The Agricultural Research Council should take the initiative in developing the plans for an effective national system for plant introduction, with due attention to plant quarantine, utilizing the facilities at the regional research institutes and the agricultural universities and colleges to the maximum extent possible for the testing and maintenance of germ plasm.

RECOMMENDATION 15. A specialist in plant introduction from the U.S. Department of Agriculture should be obtained to assist with the planning of improved plant introduction procedures, staff, facilities, and implementation.

International Cooperation in the Animal Sciences

The Near East Animal Health Institute (NEAHI) is a project financed under the U.N. Development Program and managed by the FAO. This institute has laboratories in the Middle East-North African countries and provides excellent specialized training for Asian and African students and technicians on a variety of animal disease and nutrition problems.

The Institute encourages participant training for all of the countries of the region on problems of common interest. Research and technical staff from East and West Pakistan could benefit by participating in regularly scheduled training seminars and through special problem-oriented consultations arranged with the NEAHI.

A Board of International Agricultural Science Consultants

As Pakistan agriculture achieves high productivity through the application of modern science and technology, it will be important not only to insure the prompt acquisition of new technology from other nations but also to provide for the constant review of research planning, organization, and performance in Pakistan for the maximum use of limited staff and financial resources.

Pakistan should draw upon the widest possible range of competence in agricultural science and technology in building her indigenous institutions and in developing an integrated national system of science and technology.

RECOMMENDATION 16. A Board of International Agricultural Science Consultants should be appointed, to meet annually for a two-to-four-week period in Pakistan, to assess the progress in agricultural research and to advise regarding new developments abroad. One member of the Board might be a full-time science adviser to the Agricultural Research Council, stationed in Pakistan; and serve as the secretary of the Board. This Board also would be expected to advise Pakistan research and administrative officials of the quality, and of the deficiencies, in Pakistan's agricultural research.

The membership of the Board should be limited to scientists of stature in their respective professional fields and with experience in the planning, organization and direction of research. It is suggested that a Board of six to eight members be appointed, with representation from the various scientific disciplines related to agriculture, and from research organizations throughout the world. The appointment could be for a three-year term, and on a rotation basis to permit maximum diversity in the make-up of the Board.

The Agricultural Research Council should provide the support and handle the arrangements for the appointments and annual meetings of the Board.

CHAPTER VIII

THE ROLE OF AGRICULTURAL INDUSTRIES

A short time ago the agricultural industries in Pakistan were largely limited to the production of cotton textiles, jute, tea, sugar, rice and wheat flour. Their direct contact with the farmers was limited and their influence on his production practices was negligible.

Farm Supply Industries

As modern technology is introduced the farmer comes in contact with industries that are interested in him as a customer, as the user of their fertilizers, pesticides, seed of new varieties, farm equipment, and eventually building supplies. These industries are concerned that their products meet the farmer's needs, are properly used, and give the desired results. Consequently these industries are more concerned with the farmer and his operations than were the industries that simply bought his cotton, jute, sugar or wheat.

The farm supply industry is normally competitive in several ways. There may be several suppliers of a given product and different types of fertilizers or pesticides compete for the farmer's business. With his limited financial resources the farmer must divide his operating investment between seeds, fertilizers, pesticides and equipment. The supply industry, therefore, undertakes continuing research on product improvement and their use by farmers. Furthermore, it endeavors to transmit the results of such research through their own industrial extension service, namely the salesmen, dealers, and specialists. The industrial extension service supplements but cannot replace that provided by government. And when industry and government work together the farmer benefits from their joint efforts.

The foregoing is a brief statement of what the farm supply industry has done in Europe, North America and Japan. It is just beginning to develop such a program in Pakistan. Within ten years, however, the Pakistan farm supply industries should have a large program of research and technical services to farmers. As these develop it is essential that there be good coordination and cooperation between industry and government scientists and their respective organizations.

Processing Industries

As agricultural development proceeds and diversifies, the need for processing industries increases. Processors will demand standardized, high-quality products and will, therefore, have a mutual interest in the farmer's production operations. A seed company must have high quality seed and inspects the grower's fields. The quality of fruits, eggs, poultry and other products becomes important, just as the quality of jute, cotton and tea have been in the past. In order to obtain quality products these industries conduct research and pass it on to farmers with the help of governmental agencies.

It is evident, therefore, that the agricultural industries of Pakistan will soon be having a substantial role in agricultural research and farm services. They should supplement the work of government which will, of course, continue to carry the major research responsibility in the immediate future.

The Pakistan members of this Team had only limited opportunity to observe the role of the agricultural industries in research and technical services to farmers in the United States. The matter is of such importance, however, that the Team suggests the Agricultural Research Council might have a special study made of the research and extension work of agricultural industries in several countries of Europe, North America, and Asia.

CHAPTER IX

THE AGRICULTURAL UNIVERSITIES AND COLLEGES OF AGRICULTURE

Agricultural Universities

Modern technological universities are the fountain head of a country's scientific endeavor. They train scientists and technologists for manning research centers and for industry. Their laboratories provide the scientific concepts and information basic to the development of improved technology for increasing productivity. The establishment of two agricultural universities in 1961, one in each wing of the country, constitutes, therefore, a landmark in the development of agricultural science in Pakistan.

During the past seven years, the two agricultural universities, at Lyallpur and Mymensingh, have developed rapidly into major centers of agricultural education and research. They have established Faculties/Divisions for Agriculture, Animal Husbandry, Veterinary Science, Agricultural Economics, Agricultural Education and Extension, and Basic Sciences. They have instituted B.Sc. degree courses of study in the above named faculties and have developed post-graduate programs leading to the M.Sc. and Ph.D. degrees in nearly 25 disciplines, most of these for the first time in Pakistan. In addition to the acquisition of land for experimental work, construction of laboratories, purchase of scientific equipment, books and research journals, these universities have undertaken a commendable program of providing advanced training to their teachers.

There is great need to upgrade the technical qualifications and competence of men engaged in agricultural research. Outside of the agricultural universities and the Central Research Institutes, the number of Ph.Ds working in centers of agricultural education and research generally varies from one to five. Most have only a first degree and possess no formal research training. In the provincially administered research institutes only nine per cent of research workers have a Ph.D. degree. Nearly 50 per cent of research workers in advanced countries now possess this degree. The level of training is important in research because the experience in the Ph.D. programs in planning and carrying out a research study is essential in developing the conceptual, planning, and analytical ability required in an effective research program.

The quality of research could be improved greatly in Pakistan if the facilities for post-graduate studies at the agricultural universities were fully utilized for training research workers of various research institutions. During the past six years, the Agricultural University, Lyallpur, has trained 37 members of the Ayub Agricultural Research Institute for the M.Sc. degree and 14 staff members of that Institute are currently enrolled for the M.Sc. degree and three for the Ph.D. degree.

RECOMMENDATION 17. Technical staff from research institutes and experimental stations should be provided opportunities to improve their professional capability by taking post-graduate work at the agricultural universities. The Agricultural Research Council should give special attention to fostering and supporting such programs through award of scholarships or fellowships.

In the schemes for the establishment of the Agricultural Universities, as approved by Government, the functions assigned to them are: (1) teaching, (2) research, (3) extension, and (4) short courses. In pursuance of these objectives these universities have developed research programs in all of their academic departments. A considerable time of the university teachers is devoted to research and to supervision of research. All post-graduate students must undertake research on an approved project and prepare an acceptable thesis as a part of their degree requirements.

The research varies from fundamental to adaptive with the main objectives being (1) the training of students to handle various types of agricultural research problems and (2) studies of urgent agricultural problems requiring solution in order to increase productivity. The agricultural universities are developing into important centers of agricultural research and with their physical resources and an improving level of trained staff they provide exceptional opportunities for intellectual interaction and inter-disciplinary research.

There is generally a fair appreciation of the necessity of research in natural sciences concerned with agriculture and the various agricultural research institutes in the country are engaged in a wide range of work on the physical and biological sciences. There is, however, little appreciation of the role of the social sciences in the utilization of new technology. Fields of study such as agricultural economics, farm management, cooperation and credit, marketing, agricultural and land laws, community development, and extension need greater attention because they have a vital bearing on agricultural development.

The Agricultural Universities are the principal organizations which have an institutional base for such studies. They need, however, field laboratories for the effective performance of this function.

RECOMMENDATION 18. One or more neighboring areas should be assigned to each agricultural university for intensive work, on a pilot scale, to develop integrated programs of teaching, research and extension covering both the natural and social sciences affecting agricultural development.

Agricultural research is expensive. It requires farm land, herds and flocks, seed, fertilizer and feed, farm machinery, labor and research staff. The paucity of funds for operating expenses in university departments, therefore, seriously affects the choice of research problems and distorts priorities. For example, the water buffalo may be the producer of three-fourths of the milk supply in West Pakistan, and the loss due to its low fertility may run into millions of rupees annually, but the university animal physiology department may have most of its research men engaged on problems in such fields as poultry embryology because enough funds may not be available for purchasing buffaloes for experimental work. The level of support given to agricultural universities for research by the A. R. C. should thus be commensurate with their potential in solving urgent national problems.

In view of the great increase in student numbers, e.g., at Lyallpur, from 300 to 3,000 during the past two decades and from 250 in 1961 to 1200 in 1968 at Mymensingh, the pressure for teaching drains away the meager resources from research.

RECOMMENDATION 19. The Agricultural Research Council should make special provision for research grants to the Agricultural Universities, including funds for equipment and operation of research projects.

In regard to the East Pakistan University urgent action is needed to develop the experimental farm land as rapidly as possible so the field research potential of this institution may be realized at the earliest possible date.

RECOMMENDATION 20. The East Pakistan Agricultural University farm should be developed as rapidly as possible through the use of land planes and other modern equipment required for the proper preparation of the irrigated farm for experimental work.

General Universities

Considerable research is being undertaken by the general universities in Pakistan on problems which have a direct bearing on agriculture. The work of the Dacca University Departments of Biochemistry and Soils and of the Karachi University Zoology Department on Insects and Marine Fisheries are good examples of such work. In view of the large number of highly trained scientists available in the general universities, every effort should be made to interest them in research on agricultural problems.

RECOMMENDATION 21. The facilities and staff resources of the general universities, the agricultural universities and the colleges of agriculture should be considered and utilized to the maximum extent possible in the location of research units or institutes, in the grants for specific schemes related to agriculture, and in planning coordinated research schemes in which a number of institutions may participate.

Colleges of Agriculture and Allied Disciplines

In addition to the universities of agriculture, there are the following institutions of higher education in agriculture and allied disciplines:—

Agricultural College, Peshawar. This is a constituent college of the University of Peshawar. It offers a five-year course after high school, leading to the degree of B.Sc. (Hons.) in agriculture and also the Master of Science degree in a few crop science disciplines. The college undertakes only a limited amount of research at present.

A substantial number of the staff have completed advanced training and are prepared to do useful research to advance agricultural development under present conditions, for which adequate funds and facilities should be provided.

Pakistan Forest College and Research Institute, Peshawar; The college is affiliated to the Peshawar University and offers a course of study leading to the B.Sc. degree in Forestry. It is administratively and functionally integrated with the Forest Research Institute. The Forest Research Institute undertakes a considerable amount of research in its nine research sections.

Animal Husbandry College, Lahore. This is an affiliated college of the Punjab University. It offers a four-and-a-half-year course leading to the degree of B.Sc., Vet. Sc. and Ani. Husb. Only a limited amount of research is undertaken.

Agriculture College, Tandojam. The college is affiliated to the Sind University. It offers a five-year course leading to the B.Sc. (Hons.) degree in Agriculture. Post-graduate programs are also offered in crop sciences.

The college should develop a vigorous program of advanced training for its teaching staff.

The Agriculture College, Dacca. The College offers a first degree program in agriculture, and is being shifted to a location about 23 miles from Dacca. It undertakes very limited research. Strengthening the staff by advanced training at the agricultural universities and abroad is needed.

The Education Commission and the Food and Agriculture Commission had recommended in the report of 1960 that all institutions of higher education in agricultural disciplines should be affiliated to the Agricultural Universities. While this was done in East Pakistan, in West Pakistan *status quo* has been maintained. The recent Commission on Student Affairs has again recommended that the question of affiliating such Institutions to the agricultural universities be re-examined.

RECOMMENDATION 22. The Dacca Agricultural College should be developed as a constituent college and a second campus of the East Pakistan Agricultural University. Similarly, the Animal Husbandry College at Lahore should be developed as a constituent college of the West Pakistan Agricultural University.

RECOMMENDATION 23. The cooperation between the West Pakistan Agricultural University, the Agricultural College, Tandojam, and the Peshawar Agricultural College should be improved to accelerate staff development and training, including training abroad.

Locally, all institutions undertaking research in agriculture and allied disciplines should be coordinated through effective Committees. For example, in Peshawar there are a number of institutions where research is in progress on agricultural problems including (1) The College of Agriculture, (2) The Animal Husbandry Research Institute, (3) The Agricultural Research Institute, Tarnab, (4) The Forestry College and Research Institute, (5) The Academy for Rural Development, and (6) The North Regional Laboratories of the Council of Scientific and Industrial Research. It is essential that a working relationship should be brought about for the exchange of information and for common planning. Similar action needs to be taken at Lyallpur and Tandojam, as indicated in Chapter IV.

CHAPTER X

EXTENSION OF RESEARCH RESULTS

The organization of the extension service in Pakistan and the magnitude of the task before it should be defined before considering proposals for improvement. The total cultivated area in East Pakistan is 23.6 million acres (much of which is double-cropped) with 6.13 million holdings, and in West Pakistan is 41.4 million acres with 4.83 million holdings. The extension organization to carry the plans and methods for increased agricultural production and development to the cultivator in East Pakistan is as follows:

The Province is divided into four circles, each headed by a Deputy Director. There are 18 District Agricultural Officers, 61 Sub-divisional Agricultural Officers, 411 Thana Agricultural Officers and 4,053 Union Agricultural Assistants. The individual Union Assistant has to communicate with 1,500 farm families with regard to improved agricultural practices on the 5,000 acres which they operate. A similar situation exists in West Pakistan although the holdings are larger.

In addition to communicating information on new varieties and improved production practices to farmers, the extension staff is also responsible for other agricultural changes such as removing the deficiency of oilseeds, increasing the yields of sugar cane, and introducing new types of crops, such as soybeans and sunflower. This is a large and complex assignment for a staff with limited training and only slight liaison with research.

About half of the 4,000 Union Assistants in East Pakistan have had only two years of training in agriculture after matriculation. Many were simply transferred from the jute regulating service when it was terminated and have had only little training, including some in-service training in recent years.

It is fully apparent that extension is a momentous task and that the extension worker, with limited education and training, low status and pay, without an office or transport, and inadequate housing, carries responsibilities far greater than the support and recognition given to him.

The Provincial Governments are aware of the deficiencies of the extension organization and are taking important steps to improve it. East Pakistan is developing a United Nations Development Program project that will provide for training, physical facilities and technical assistance on a considerable scale. West Pakistan plans to have all field assistants on SCARP II, more than 100, well trained B.Sc. (Agriculture) men. This will be the first time an area has been completely staffed by men of such high qualifications.

Since the terms of reference of the Joint Team relate primarily to problems of effective coordination of research with extension and other development organizations our recommendations will be directed primarily to those areas.

Linkage between Agricultural Research, Extension, and the Cultivators

In the rapidly changing agriculture now in progress in Pakistan the communication of research findings on improved production practices to the farmer and the prompt reporting of production problems to research scientists is a vital link in the advancement of agricultural production.

The extension staff must have sources of dependable technical and practical information or recommendations on improved farm practices. This requires a close, continuing linkage between the research centers and the extension leaders and staff.

The decision of the Government of West Pakistan to set up separate "Directors" of Research and of Agriculture (Extension) in each of the three regions has increased the problem of coordinating and relating research findings to the extension programs. Adequate communication and coordination between research and extension technical staffs is lacking and must be improved.

RECOMMENDATION 24. In order to strengthen the communication and coordination between research and extension it is proposed that extension subject matter specialist positions be established in each extension region of Pakistan. There should be specialists in agronomy (field crops), plant protection, soil and fertilizers, animal husbandry and other subjects as needed. They should be located at the regional research institutes and/or in the agricultural university or college of their region.

Qualification for these positions should require an M.Sc. degree from an Agricultural University and training in modern extension education methods, including field experience in conducting field demonstrations of improved agricultural methods.

The specialists should be under the administrative supervision of the Director of Agriculture (Extension) but should obtain technical guidance for recommendations on improved practices from the research stations or projects. They should have adequate travel funds and facilities and freedom of movement in the region, spending the major part of their time in the field in training and advising extension staff.

Representatives of the East Pakistan World Bank Team also favour setting up a team of extension specialists who, along with their other duties, would be responsible for maintaining contact between research and extension field staff. In addition, they suggest that specialists should be stationed at the divisional (circle) level.

The Duties of the Extension Specialist

1. Maintain close contact with research scientists to keep up to date on research in progress and research findings.
2. Participate in agricultural extension program planning involving his subject area.
3. Arrange and/or conduct subject matter and training meetings for Union agricultural assistants (or field assistants) on procedures and subject matter for effective field demonstrations for farmers. Research scientists should also participate when available.
4. Receive from the extension field staff, and report to appropriate research scientists, new problems confronting the farmers.
5. Assist in the preparation of pamphlets, bulletins and other written material on research findings for use in educational programs with farmers. All such pamphlets should be prepared in close collaboration with the research scientists concerned and should have approval of the appropriate research staff before release.
6. Assist in the preparation of articles and presentations for the press and radio on new recommended production practices.

Extension Cooperation with ADC, WAPDA, SCARP and Industry

The extension specialist should cooperate closely with ADC officials to bring the ADC staff up-to-date with respect to research and extension recommendations on crop protection, crop production, improved varieties, soil and water management, and agricultural engineering, etc. Research scientists should participate in such meetings to the maximum extent possible.

ADC should have the benefit of prompt agricultural research and extension recommendations in adjusting their procurement and supply planning operations. Meetings to discuss and review new research results are much more effective in achieving prompt understanding and rapid adoption than are pamphlets or bulletins.

Similarly, information relating to research findings on water requirements of crops and water use and management for crop production, etc., should be furnished to WAPDA and SCARP staff by the extension specialist. This type of contact would provide opportunities for the discussions of engineering and agricultural problems as found by agricultural extension and research, to the mutual advantage of the respective organizations.

Industries related to agriculture should be contacted by the specialist who can cooperate with them in planning educational materials for farmers. Industry-extension cooperation in demonstrations, field days and village fairs and festivals have proven useful in many countries.

IMPLEMENTATION

The Team understands that the Report will be examined by the Central and Provincial Governments in the next few months and decisions reached as to acceptance of the various recommendations. Government will then be confronted with the task of implementing these recommendations, with several of them having significant financial implications. Time permits making such provisions in the Fourth Plan. Many recommendations, however, do not have much financial implication and can be implemented by minor adjustments in the current Plan.

The Team recognized from the beginning that some of the recommendations it would be making would have an influence on the programs in which foreign economic and technical assistance agencies are participating. All the major agencies were contacted, were helpful, and we believe are prepared to be of assistance in the further development of agricultural research in Pakistan along the lines recommended in the Report.

The development of a nation's agricultural research institutions and program is a continuing, never ending process. We, therefore, suggest that the Government plan for a second agricultural research team in about three years, to review the implementation of the present Report and suggest further measures for the development of agricultural research in the country.

OFFICE OF THE WHITE HOUSE PRESS SECRETARY

THE WHITE HOUSE

EXCHANGE OF TOASTS

BETWEEN

PRESIDENT LYNDON B. JOHNSON

AND

PRESIDENT MOHAMMED AYUB KHAN

OF PAKISTAN

(In the State Dining Room)

(AS ACTUALLY DELIVERED AT 10:15 PM EST)

PRESIDENT JOHNSON: Mr. President, distinguished guests, ladies and gentlemen:

There is no need to say how very pleased we are, Mr. President, to welcome you to this house this evening. The President of Pakistan comes on a new visit, but he is a very old friend. This is his third journey here as head of a young State already grown to world importance.

Mrs. Johnson and I want to thank you, Mr. President, for honoring us with your distinguished Ambassador Ahmed and his charming wife whom we enjoy very much.

We are also particularly pleased that we could renew acquaintances with your former Ambassador, your present Foreign Secretary. I observed that perhaps when he was Ambassador and I was Vice-President we were doing a little better job with our relations than we are in our new positions. But it just shows you what happens to people when they get promoted.

President Ayub and I have a great deal in common, just as our peoples share many values and many dreams.

President Ayub is a rancher as I am. His home district is country much like Johnson City, Blanco County, where I live. He also has a special bond with Mrs. Johnson, and for that matter, all lovers of beauty in this land. President Ayub is building a new capital for his country, just as we are trying to rebuild and beautify ours.

With so much to share it is not surprising that President Ayub and I found our talks today fruitful. They will continue in the evening and we hope for more extended sessions tomorrow.

We share the basic values and beliefs; man's fundamental dignity and worth, a love of liberty, a pride of excellence, pursuit of beauty and truth, a vision of a better and a fuller life for all human beings.

I have recalled a courageous and a compassionate appeal made by President Ayub in a broadcast back in 1963. He said then—and I quote; "Hatred and anger fan the fires of hell in human minds. Why not put them out? It is nobler and better for one's own happiness to live on terms of friendliness with others."

And so tonight we share the greatest hunger and the most burning thirst of all. We want so much to find peace in the world. We want so much to bring peace to Asia and peace to all the other countries that are troubled. We want peace not only in our time, but peace for all time. We want peace. And we shall work every minute, day and night, for peace.

President Ayub visits us as the architect of his country's inspiring struggle for economic emancipation. And nowhere have we observed a better administrative effort. Today Pakistan surges forward in a very great adventure—and Dave Bell will talk to you about it for hours if you will listen to him—because we are very thrilled to observe the economic advances and the other results that the leadership of President Ayub and his associates provide and inspire. We all must rededicate our very best efforts to conquering the curses of poverty, hunger, disease, illiteracy, the human and physical problems that, as President Ayub has said, and I quote him again: "cannot be resolved by the magic wand of just freedom alone."

So Mr. President, with your permission, I am sending a very high level team of medical teachers and scientists shortly to your country of Pakistan. This team will be led by the President's Science Advisor, my own trusted counselor, Dr. Donald Hornig. Its mission will be to work with your own medical authorities in instituting a very broad improvement in medical training, and working with all of your fine people in the attempt to improve rural health and public health among your fellow countrymen.

This will be a beginning. If our purposes are as one, we can continue and expand the dynamic partnership that we have had in the past. Together we can press the battle against water-logging and salinity; against devastating cyclones; cholera, heart and eye disease. Together as friends working shoulder to shoulder we can improve weather-forecasting and improve flood warnings, and multiply housing programs such as the Korangi project that I visited in 1961 when I met my good friend the camel driver. He came to this country and he spread good will from one end of it to the other, and he is remembered most affectionately by all who met him. We can speed in many ways the transition from a subsistence economy to a life of plenty, and a life of purpose for every Pakistani.

This has been a stimulating and inspiring day for me. It is always so when I am in your presence.

So tonight, here in this, the first house of our land, I would like to ask those friends of mine who I have asked to come here from various parts of this country—California to New York—to raise our glasses to salute the spirit and the success of the Pakistan nation, and the dedicated leadership of the great President of Pakistan, Mohammed Ayub Khan.

PRESIDENT AYUB KHAN: Mr. President, Mrs. Johnson, your Excellencies, ladies and gentlemen:

I am deeply touched by the warm reception given to me and my party and by your great hospitality tonight. You are a generous man. I am only talking to a friend now. May I have the liberty of doing so with a great heart.

I am so very happy that this great country has a man like you, sir, at its head, and that is how it should be. It is only people with large hearts, broad understanding, forgiveness, and so on, that can tackle the sort of responsibilities that devolve on you. Not only responsibilities on behalf of your country, but, in fact, on behalf of the world even, because you are the head of the mightiest country in the world.

As far as Pakistan is concerned—the people in Pakistan are concerned—there has been very friendly and warm relations between our people.

Lately—and I would be less than honest if I did not admit it, since I was largely responsible for this friendship and understanding between our two countries—it hurts me to say that our relations have, to a certain extent, been soiled, and I think that has happened because of a lack of understanding of each other's difficulties and problems.

You have certain obligations and certain problems which you are facing, of which we are aware of. We have certain difficulties in the location and the situation in which we live.

You have been very generous and kind to invite me to come to your country to see you and talk to you in heart-to-heart fashion. And I have with all sincerity and honesty put to you our problems, and you have been good enough to tell me your problems.

I think that in countries like yours and mine, situated so far away, with different sorts of obligations, locations, and so on, and so forth, friendships can be maintained—and they must be maintained. And the way to maintain them is to bear friendship with friendship and understand each other's difficulties, and don't do anything which is against the interests of a friendly country.

I have no doubt in my mind if that principle is observed—we certainly will observe it, sir—there is no reason why our friendship should not continue.

Your country and your people have in many ways been assisting us, and I am the first one to admit it. Not only do I do so in my heart, but I do so in front of my people. And it has been a very stimulating experience for our mutual relationship.

We regained our independence after a long time. In a period when the world has shrunk, peoples' expectations have risen. They want the good things of life quickly. Demands on government, therefore, have increased enormously. After all, it takes time with the best will in the world and the best effort in the world to produce results.

The people are not prepared to wait. They are impatient. Therefore, there is great pressure, tremendous pressure, in our country to produce results to the satisfaction of the people. We have been, in our humble way, trying to improve the conditions of our people, and remove sufferings and wants, and so on.

I think we made a considerable success in that. One lesson I learned from that was that the people really try to improve their lot once they are given the right direction and the opportunity.

Lately, unfortunately, we have been bedeviled with a major conflict. My own hope and prayer is that we shall be able to overcome. My endeavor always has been to live in peace with our neighbors, especially with our big neighbor, India. They have tremendous problems and we have tremendous problems.

We need peace. We need peace not only for the sake of peace but also for the sake of doing a very noble task of improving the lot of our people.

In that connection, I am very grateful to you, sir, for sending this mission out. I am sure that it will be appreciated, and I am sure that they will get the fullest cooperation from our people and they will benefit by their experience.

The last time I was here President Kennedy and I had long discussions. I mentioned to him about this problem of water-logging and salinity in West Pakistan. Those of you who are familiar know the circumstances there. Our agriculture is totally artificial in West Pakistan. It is dependent on artificial irrigation. I think—I don't know whether I am right in saying—but it is probably the biggest, shall we say, artificially irrigated area in the world in one block—some 32 million acres of land.

And through this process of irrigation the water table has gone out, the salts have come up, and we were facing tremendous problems. And he was good enough to send a team of scientists out, and they have done, in conjunction with our people, a tremendous job. I am sure if your set of people come they will have a second look at these things. We made a start in this project and we made a great success.

So, I am very grateful to you for this offer. Our effort really is to do the very best we can for our people.

We also find that our population is growing at a rate which is not acceptable, and which can create serious problems. That is another thing that we are putting our major efforts on.

Similarly with our agriculture, and so on, results have been very heartening. And so any advice and assistance of that nature will be most welcome, in keeping with the wishes and the desires and endeavours of the people.

I am glad to see that after your major operation—apparently it has been a very serious one—you are looking so well and regaining your health. I hope you will regain your full vigor.

May I say that the talk we had together has been very exhilarating for me. You have been patient enough to listen to me and I do hope that you will be convinced of my sincerity. I may be wrong in my approach but you can be assured of my sincerity of approach.

I have no doubt that if we understand each other's difficulties there is no reason why our friendship can't last forever.

So, I thank you for all the understanding you have given me and us all, and this warm welcome and great hospitality, and also given me the opportunity of meeting you again. It has done my soul a lot of good.

So, in return for that, may I ask you ladies and gentlemen to join me in drinking to the health and happiness of the people of the United States of America.

Mr. President, Sir.

APPENDIX II

MEMBERS OF THE JOINT PAKISTAN—AMERICAN AGRICULTURAL RESEARCH TEAM

Mr. M. Yamin Qureshi, S.K.,
Joint Secretary, Ministry of Agriculture
& Works (Agriculture).

Mr. Qureshi began his association with agriculture in 1944 as Assistant Director, Ministry of Food, Government of India. In 1947, he was appointed Under Secretary, Ministry of Food & Agriculture, Government of Pakistan. He has been in his present position since 1964. In addition to the Joint Secretary's responsibilities, he is Vice-Chairman of the Pakistan Central Cotton Committee, former Chairman of the Agricultural Research Council, Director of the Agricultural Development Bank of Pakistan, and a member of the Pakistan Central Jute Committee. Beyond the many National recognitions, he has been chosen to attend numerous international meetings. He was Pakistan delegate to the Law of the Sea Conference of the United Nations, 1958 and 1960, and had been a member, leader and alternate leader to many FAO and CENTO conferences.

Dr. Zafar Ali Hashmi, Vice-Chancellor,
West Pakistan Agricultural University, Lyallpur

Dr. Hashmi graduated from the Punjab Veterinary College, Lahore, in 1935. He was selected as a Government of India State Scholar in 1946 to pursue advanced studies and research at Michigan State University, where he obtained his Master of Science degree from the College of Agriculture and a degree of Doctor of Veterinary Medicine. He will receive an honorary D.Sc. from Michigan State University on June 9, 1968.

On his return from the USA in 1948 he was engaged by the Central Government of Pakistan to lead studies and research on the production of bio-logicals for the control of epidemic prevalences in domestic livestock, then promoted as Officer-in-Charge of the Pakistan Animal Husbandry Research Institute. In 1954 he was again promoted and transferred to Quetta where he created a model livestock disease control and animal production organization as the first Director of Animal Husbandry in Baluchistan. In recognition on his outstanding achievements as a scientific worker and administrator, he was made Director of Animal Husbandry, West Pakistan and the Animal Husbandry Commissioner, Government of Pakistan. In 1961 he was appointed the first Vice-Chancellor of the West Pakistan Agricultural University at Lyallpur, and entrusted with pioneering and developing an institution of foremost importance and interest to the nation.

Dr. Hashmi has to his credit 32 years of service of exceptional merit and, as a scientist and an educator, he ranks among the foremost in the country. He is a prolific writer and has contributed more than 70 valuable publications on various subjects.

Dr. Kazi M. Badruddoza, T.I.,
Director of Research (Agriculture)
Agricultural Research Council

Dr. Badruddoza received both his Bachelor and Master's degree from Dacca University and his Ph.D. in Botany from Louisiana State University. Post-doctorate work was done at the Institute of Genetics, Lund, Sweden.

He began his professional career as a Mycological Assistant in the Department of Agriculture in East Pakistan in 1948. Increasingly important assignments were given to him and he was appointed to his present position in 1964.

He has served on many important National and International Committees. His assignments included: member-delegate to the First Near-East Seminar on Higher and Intermediate Agricultural Education in Beirut, Lebanon, in 1963; member-delegate to the SEATO Regional Agriculture Research Study Group in 1966; member-delegate to the CENTO Conference on National and Regional Agricultural Development Policy in Istanbul in 1967; member of the Pakistan Central Jute Committee.

He has authored many scientific papers and reports.

Dr. Frank W. Parker

Dr. Parker received his B.S. degree from Alabama University and his Ph.D. in Soil Science from the University of Wisconsin in 1921.

He began his professional career as Soil Scientist at the Alabama Agricultural Experiment Station of Auburn University in 1922-28. He served as a Senior Soil and Fertilizer Specialist with the Dupont Co., from 1929 to 1942. In that capacity he worked with research chemists, engineers, the fertilizer industry and agricultural research organizations. From 1942 to 1953 Dr. Parker was in charge of Soil, Fertilizer and Water Management Research of the U.S. Department of Agriculture with headquarters at Beltsville. This position carried responsibility for extensive coordinated research projects in which the USDA, the state universities, and other organizations took part.

Dr. Parker served as Agricultural Adviser to the Ministry of Food & Agriculture, Government of India, and Food & Agriculture Officer U.S. AID (India), from 1953 to 1959. He served as Assistant Director-General, Technical Department, Food & Agriculture Organization, Rome from 1959 to 1962 and helped organize the FAO-Industry Fertilizer Program of the Freedom from Hunger Campaign.

In 1962-1965 Dr. Parker organized the AID Agricultural Research Program which has 20 major projects in different parts of the world.

Since his retirement in 1965, he is serving as a consultant to AID, OECD, CENTO and the chemical industry.

Dr. Albert H. Moseman

Dr. Moseman received his B.S. and M.S. degrees from the University of Nebraska and his Ph.D. in Plant Breeding and Genetics from the University of Minnesota in 1944. He also holds an Honorary D.Sc. from the University of Nebraska.

He began his professional career with the Coordinated Federal-State Wheat Improvement Research Project in 1936, located at the Nebraska Agricultural Experiment Station as a member of the U.S. Department of Agriculture Bureau of Plant Industry. He con-

tinued with this organization in research and administrative roles and served as Chief of the Bureau from 1951 to 1953. From 1953-56 he was Director of Crops Research, Agricultural Research Service, U.S.D.A.

Dr. Moseman was a member of the team sent by the U.S. Department of State in January-April, 1950 to discuss with government officials of Near East and Asian countries the prospects for cooperation in agricultural development to be undertaken under the then proposed Point IV Program. In 1955 he was a member of the First Joint Indo-American Team on Agricultural Research and Education. He has served as the agricultural specialist on teams headed by the President's Science Adviser, Dr. Donald F. Hornig, to review Science and Technology programs in Korea, in 1965, and in Taiwan, in 1967.

From 1956 to 1965 Dr. Moseman was with the Agricultural Sciences Program of the Rockefeller Foundation and was Director of this program for 5 years. He served as consultant on research to the Secretary of Agriculture in 1963, and from 1965-67 was Assistant Administrator, Office of Technical Cooperation and Research, U.S. Agency for International Development.

Dr. Moseman is now associated with the Agricultural Development Council, a private foundation supporting teaching and research for agricultural development in Asia.

Dr. Nels M. Konnerup

Dr. Konnerup received his B.S. and DVM degree from Washington State University in 1941 and 1942.

He entered large animal veterinary practice and supervised the first cooperative Breeder Artificial Insemination Organization in the North Western States.

In 1946 he joined the United Nations Rehabilitation Administration serving in Europe and China. Later he was employed by the FAO serving in Latin America, Africa and the Far East.

From 1956 to 1962 Dr. Konnerup was with the Economic Research Service of the U.S. Department of Agriculture where he served on a Livestock Economic Survey Mission to Latin America, an Agricultural Trade Fair Mission to the United Arab Republic and on an Agricultural Exchange Team to the USSR.

In 1963 he joined the Walter Reed Army Institute of Research, Preventive Medicine Division, where he became Acting Chief of the Health Data Department. In 1964 he headed, as a Consultant to the U.S. National Academy of Science/National Research Council, a survey team on Animal Agriculture in West Africa. He was appointed a Panel Member on the President's Advisory Committee on World Food Problems in 1967 and participated in the preparation of the Committee Report.

In 1967 he joined the Agricultural and Rural Development Service of the Office of Technical Cooperation and Research, Agency for International Development, as a Livestock Disease Specialist.

Dr. Konnerup is a Diplomat of the American Board of Public Health and an executive officer of its Board. He is Chairman of the Foreign Animal Disease Committee of the United States Livestock Sanitary Association and the editor of the Association's publication "Foreign Animal Diseases". He is also a member of the National Library of Medicine/National Agriculture Library Joint Committee on Veterinary Vocabulary and Nomenclature.

Dean F. Earl Price

Dean Price received his B.S. degree from Oregon State University in 1922 majoring in agricultural engineering and irrigation.

He began his professional career with Montana State University in Extension. He returned to Oregon State University in 1923 as Extension Specialist in Agricultural Engineering. In 1928 he was transferred to the Agricultural Experiment Station in charge of research on Rural Electrification.

In 1940 he was appointed associate Dean of Agriculture of Oregon State University and in 1951 he was appointed Dean and Director of Agricultural Research and Extension where he continued until he retired in 1965.

In 1953 he took leave to serve as consultant to the Director of Agriculture of Brazil on sprinkler irrigation of coffee.

In 1959 he spent 5 months in Thailand as Consultant from Oregon State University to Kasetsart University in Bangkok, on University Development on the AID/Oregon State University contract.

In 1965 he was employed by the University of Illinois and served 2 years in India as Chief of Party, and adviser to the Vice-Chancellor of the U.P. Agricultural University, on a US AID University of Illinois contract for University Development.

APPENDIX III

**ITINERARY OF THE PAKISTAN AGRICULTURAL RESEARCH
TEAM MEMBERS IN THE UNITED STATES**

(February 2—25, 1968)

<i>Date</i>	<i>Institutions</i>	<i>Persons contacted</i>
February 2,	Arrived in Washington D.C.	DR. GEORGE L. MEHREN, Assistant Secretary. MR. BYRON G. ALLEN, Assistant to the Secretary.
February 5.	U.S. DEPARTMENT OF AGRICULTURE, WASH- INGTON, D.C.	DR. R. J. ANDERSON, Associate Administrator, Agricultural Research Service. DR. NED D. BAYLEY, Deputy Director, Agricultural Research Service. DR. W. D. MACLAY, Director, Research Program Development & Evaluation Staff, Agricultural Research Service. DR. J. H. STARKEY, Director, International Programs Division, Agricultural Research Service. DR. LESTER R. BROWN, Administrator, International Development Service. DR. L. J. MCMILLAN, Acting Chief, Special Programs Branch, Foreign Training Division. DR. T. C. BYERBY, Administrator, Cooperative State Research Service.

Date

Institutions

Persons contacted

Date	Institutions	Persons contacted
		DR. T. S. RONNINGEN, Acting Associate Administrator, C.S.R.S.
		DR. LLOYD H. DAVIS, Administrator, Federal Extension Service.
		DR. M. L. UPCHURCH, Administrator, Economic Research Service.
		DR. A. M. ALTSCHUL, Director, High Protein Foods, International Agricultural Development Service.
February 6.	AGRICULTURAL RE- SEARCH CENTRE, Beltsville, Maryland.	MR. VICTOR L. SIMMONS, Visitor Service Office.
		DR. H. REX THOMAS, Director, Crops Research Division & Others.
February 7.	AGENCY FOR INTER- NATIONAL DEVELOP- MENT.	AID officials.
February 8.	ROCKEFELLER FOUND- ATION.	DR. STERLING WORTMAN, Director, Agricultural Sciences.
		DR. RALPH CUMMINGS.
		DR. L. M. ROBERTS.
		DR. R. W. RICHARDSON.
	FORD FOUNDATION	DR. LOWELL HARDIN.
		MR. WILLIAM RUDLIN.
	AGRICULTURAL DEVE- LOPMENT COUNCIL.	DR. C. R. WHARTON, Vice-President.
		DR. A. H. MOSEMAN.
February 9, February 13.	NORTH CAROLINA STATE UNIVERSITY.	DR. F. S. SLOAN, Professor, Extension Studies and Training. Agricultural Extension Service.

<i>Date</i>	<i>Institutions</i>	<i>Persons contacted</i>
		DR. J. A. RIGHEY, Office of Foreign Programs.
		DR. R. L. LOVVORN, Director of Research, SUPERINTENDENT, North Carolina Experiment Station.
February 15,	TEXAS A & M	PRESIDENT RUDDER, Texas A & M University.
February 16,	UNIVERSITY.	DR. JACK D. GRAY, Director, Office of International Programs. Administrative Personnel, Experiment Station. Administrative Personnel, Extension Service. Officials of the various research departments.
February 19,	KANSAS STATE	DR. JAMES A. MCCAIN, President, Kansas State University.
February 20,	UNIVERSITY.	DR. FLOYD W. SMITH, Director, Agricultural Experiment Station. DR. R. V. OLSON, Head of the Department of Agronomy. DR. PAUL L. KELLEY, Head of Department of Agricultural Economics. DR. W. J. HOOVER, Head of the Department of Grains Science and Industry. DR. JOHN A. JOHNSON, The Food and Grain Institute. DR. HERBERT W. BULK, County Extension Agriculture Agent, Shawnee County.

Date	Institutions	Persons contacted
February 22,	SOMMER BROTHERS SEED COMPANY.	Manager, Sommer Brothers Seed Company.
February 23.	WASHINGTON STATE UNIVERSITY, Pullman, Washington.	DR. ALLAN A. SPITZ, Acting Director, Office of International Programs.
		DR. O. A. VOGEL, U.S. Department of Agriculture, Agricultural Research Service, Coordinator of Wheat Research.
		DR. MATSON, Dean of Agriculture, Washington State University.
		Director of Extension and other University Officials
February 25.	Departure from the United States of America.	

APPENDIX IV

OBSERVATIONS ON RESEARCH IN THE U.S.A.

Like Pakistan, the U.S.A. also started with an economy which was predominantly agricultural. About 75% of its population was employed in agricultural production in early 1800. But as the technology of farming improved and industries developed, the proportion of population employed in agriculture started reducing and today, it is only about 7%. In spite of a very limited numbers of workers engaged in agriculture, the achievement in agricultural production in the U.S.A. has been of very high order. This can very well be illustrated by the following table:

YIELDS OF SELECTED CROPS—HARVESTED ACRE*

Crop	Unit	1951-53	1958-60	1963
Corn, all	Bushel	39	53	67
Oats	Bushel	33	42	45
Sorghum	Bushel	18	39	43
Rice, rough	Cwt.	24	33	40
Cotton	Pounds	291	459	516

*Fact Book of U.S. Agriculture, U. S. D. A. (1965).

In 10 years' time the production of corn, oat, sorghum, rice and cotton per acre increased by 72, 27, 94, 66 and 77 per cent respectively. Similar increase was also attained in almost all other crops. This progress has only been possible due to technological advancement in agriculture through research investments. Farmers in the USA today, are much more knowledgeable and much better managers than a generation ago.

Agricultural research in the U.S.A. is carried out by the Federal Government, the State Governments and the Private Industries.

The U.S.A. Department of Agriculture, under the Federal Government is headed by the Secretary of Agriculture, a position comparable to the Minister of Agriculture in Pakistan. It has a number of services such as Agriculture Research Service, Agricultural Extension Service, Agricultural Marketing Service, Farmers' Cooperative Service, Forest Service, Statistical Service, etc. Of these, the Agricultural Research Service is the largest and is responsible for promotion of agricultural research.

The Federal Government provides research funds to the States in the form of Grants to the State Experiment Stations, Facilities Grants for construction and Research Project/Grants.

All Research Projects sanctioned for the States are first considered by Land Grant College Committees. There are four Regional Committees which aim to coordinate research of regional basis and decide on projects deserving financial assistance from the Federal Government Regional Research Funds.

There are a number of well balanced coordinated regional research projects on important crops or problems and every regional research project has a coordinator who is a working scientist under the State Government or the Federal Government. His responsibilities as a coordinator do not occupy all of his time. The main feature of his role is to plan, on a national scale, a joint undertaking for research on a particular commodity or problem. He assumes the leadership in joint planning and execution. He arranges for adequate co-operation of all related disciplines, and ensures that all co-operating discipline and participating scientists have a voice in both the planning and execution of the research. Specifically his duties include:

- (a) Visiting all cooperating units as often as necessary to ensure adequate liaison among all cooperating stations.
- (b) Preparing an annual report with materials supplied by participants giving proper credit to all of them.
- (c) Keeping all participants fully informed of the plans of research.

Necessary funds for the efficient discharge of his duties are provided by the Federal Government.

Apart from providing funds for agricultural research to the States, the Federal Government has established a number of regional/national research centres. Mention may be made of Soybean Research Centre in Illinois, Salinity Research Laboratory at Riverside California and Agriculture Research Centre, Beltsville.

The Agricultural Research Centre, Beltsville is located on 10,000 acres of rolling Maryland countryside north of Washington, D.C. and constitutes national headquarters for agricultural scientific investigation.

The principal role of scientists and administrators at the Centre is to provide direction and leadership to agricultural research efforts of the country. The research work at the Centre deals primarily with problems of national interest. Many of the ideas conceived and tested at the Centre provides the basis for further investigation at regional and state levels.

The Central building complex includes 67 laboratories, 36 green-houses, and 700 barns and poultry houses as well as storage and maintenance facilities.

The Centre has ten Research Divisions such as Agricultural Engineering Division, Animal Diseases and Parasite Research Division, Crops Research Division, Entomology Research Division, Soil and Water Conservation Research Division, etc.

A national research centre of such size and wide range of activities is, perhaps, the largest in the world and is a source of attraction to scientists from all over the world.

The agricultural research and extension in each State is the responsibility of the Land Grant Universities established under the Morrill Act (1862) which granted public land to the states to assist in the establishment and maintenance of at least one College/University in a state to promote agriculture. Every State now has a Land Grant University.

Each Land Grant University is constituted of several schools/faculties. Agriculture is one of the faculties. Other usually are engineering liberal arts, veterinary science, home economics, medical science, law, etc. The school of agriculture may be split into many departments like agriculture, engineering, agronomy (crops and soils), genetics, animal science, plant pathology, entomology, horticulture, agricultural economics, rural sociology, etc. The school of agriculture is thus a part of a Land Grant University. But it is a very important part. The special importance of the school of agriculture lies in the fact that it organizes experimental stations and extension services in the State. The Land Grant Universities are similar to the agricultural universities in Pakistan. They are distinguished by a well defined characteristic-integration of three activities in the same institution—e.g., resident teaching research in agriculture and related sciences and extension service in agriculture and home economics within the States.

The Chief Executive Head of the Land Grant University is the President/Chancellor. The Dean is the immediate Head of each School/Faculty under whom there are Directors of three different branches such as Resident Teaching, Research and Extension. The Dean has an Advisory Council that advises on all matters relating to research, teaching and extension.

A most striking feature of the Land Grant Universities is that the benefits of centralised facilities of various schools/faculties and of research departments in one campus can be fully and promptly exploited.

In the field of research, there is a significant cooperative effort between the United States Department of Agriculture and the Land Grant Universities. This cooperation is not limited merely to the Land Grant funds attached to the Universities, but also extends, as already mentioned, to a large number of research projects for which Federal assistance is available in various forms. In many of these projects, the Federal Government pays for the staff who are stationed at the Universities. Such staff work as a part of the University and are even treated as members of the Faculty. The working is so harmonious and effective that these Federal Staff members are hardly distinguishable from the regular staff of the Faculty. Many of the Federal Staff guide post-graduate students for their research projects in the fulfilment of their requirement. This is an excellent example of co-operation between the Federal Government and the State Governments.

The initiative for planning research programme usually comes from the workers. But the program is subjected to a careful scrutiny at various levels. In this matter, the Director of Research usually seeks the help of a Committee of Specialists. In developing a research project, measures are taken to promote an inter-disciplinary approach so as to avoid any gaps and attain the objective in the most effective manners.

Research is considered as an integral part of teaching and almost all teachers are required to do some research in the Land Grant Universities. Such teachers are called upon to teach four to six hours a week. Few Professors have to take over full teaching load with no research program.

There are also a large number of research projects at the Universities supported by public donations or endowments, including industrial or farm commodity organizations. Besides, many agricultural industries have their own staff engaged in various fields of agriculture.

The funds available, at present, from various sources for agricultural research are roughly as follows:

Federal Government	..	..	..	..	250 m. dollars.
State Government	..	..	..	..	175 m. dollars.
Industries	..	..	..	..	400 m. dollars.

More than 48 per cent of the funds come from Industries and this clearly indicates the important role played by the industries for the promotion of agricultural research in the U.S.A. This is followed by the funds spent by the Federal Government, which is about 30 per cent.

Qualifications are prescribed for each research post, depending upon the nature of work expected for the prospective incumbent and recruitment of persons for research is generally done by the research department heads.

The evaluation of research workers is done annually, on the basis of professional competence, publications etc., in the form of a recommendation for promotion or increase in emoluments. Full justification has to be furnished in each case and each proposal is subject to scrutiny by the higher authorities. This system appears to have provided a good stimulus for able workers to display sustained enthusiasm.

Merit and professional competence are the principal factors in promotion and seniority has relatively little importance.

Co-ordination and communication among and between agricultural scientists in the U.S.A. are accomplished in various ways. All research organisations including the Land Grant Universities and the U.S.D.A. encourage research workers to attend science conferences and provide for necessary financial support to permit attendance. This helps the workers to be in touch with their professional colleagues, discuss problems of common interest, and benefit from the experience and view points of other associates. Seminars, panel discussions and frequent personal contacts play a great role in bringing about desirable co-ordination. Professional and scientific societies provide opportunities for fostering scientific inter-charge as well as developing after careful study, policy recommendations.

The head of a Research Department of the University has the responsibility to see that research information available in his subject is brought to the notice of extension workers. This is done with the help of a number of extension specialists.

The Extension Specialist is the extension area of the specialist department such as Entomology or Agronomy and his position is the logical result of the integration of agricultural research and extension. The research department tackles the problem and provides solutions, and the extension organization passes on the information to the farmer. The research worker is concerned with the technical problem and does not have the time and may not have the temperament to disseminate the results of his research. Similarly, the extension worker finds that what he has learned in college may rapidly become outdated

and realizes that he must consult with research scientists to keep pace with all the developments in his special field. The working arrangement has been so effectively devised in the U.S.A. that an Extension Specialist, specialized in a subject matter field, is in constant touch with it; and at the same time, has an aptitude for extension work. He works as a close link between the research worker and the extension worker and enables the latter to be up-to-date with the whole knowledge of the research organization and brings farm and farmers problems to the attention of research workers.

The extension specialist is attached to the subject matter department but works under the joint control of the research department and the extension director. He is highly qualified, usually a Ph.D. with aptitude for extension work. There are usually 25—75 extension specialists at each Land Grant University in such fields as animal husbandry, dairying, poultry, agriculture engineering, agronomy, entomology, marketing, market price analysis, etc. The extension specialist carried out special demonstration tests in collaboration with the extension worker. About 200 demonstration tests are usually carried out by an extension specialist in a year.

Normally the County Agent, an extension worker in a County usually with an area of 600 sq. miles and 1000-2000 farm family, prepares an annual program covering the subjects which are of special interest in his country. This is passed on to the Specialists who establishes the dates on which they will be available at different places. On receipt of this, the County Agent arranges a meeting at a suitable place and time. He also issues a large number of information letters to farmers. The meeting is usually attended by 100 or 200 farmers, the County Agent and the Extension Specialist/Specialists. The list of his specific duties is given below:

1. Keeping state and county extension workers upto-date with regard to the findings of science and their application to the solution of farm and home problems.
2. Serving as a bridge between subject matter research departments and field extension workers; interpreting the results of research in terms of desirable farm and home practices.
3. Assembling and analysing facts, clarifying problems in the subject matter field, studying the status of his enterprise through out the state and the nation.
4. Helping county agents to develop sound county and community programs in which subject matter is correlated to best serve the interest of the farm and home as a family unit.
5. Assisting agents in the effective use of teaching methods peculiary adopted to the subject matter involved.
6. Backing up the county programs with suitable state-wide publicity, popular bulletins, farm letters, motion pictures, film strips, slide exhibit materials, and other teaching aids.
7. Making studies to determine successful and unsuccessful methods of organizing and conducting extension teaching in the particular subject matter field.

8. Outlining and measuring devices and procedures applicable to the subject matter problems being attacked and assisting agents in their use.

9. Handling direct teaching of rural people within the county in such a manner as to strengthen the position of the county worker and enable him better to meet subject matter problems arising after the specialist's departure.

The Extension Specialist has also the responsibility to training of County Agents and passing on the new information to them. This is done in the course of visits and also in the District Meetings of County Agents and in the summer school training courses at the University.

Unlike the Provincial Agriculture Departments in Pakistan, the State Agriculture Departments in the U.S.A. are mainly responsible for such regulatory and service functions as enforcement of laws relating to grading and standardization of milk and other agricultural produce including seeds; fertilizers; control with regard to its type and quality; disease prevention in livestock; advice to cooperative societies; collection of agricultural statistics; analysis of soil samples; marketing intelligence; technical and supervising guidance; and working in close cooperation with the Land Grant University.

East State has an effective information service. The information service is a part of the University. Many Universities have their own radio and television stations which the extension and research workers frequently use.

News bulletins, interviews with reporters, meetings, group programs, "field days", visual aids such as slide photographs and charts are frequently used as tools for dissemination of results of research.

Farm demonstrations or trials on one or several farms in a community have proved of great value. A demonstration, however, must be distinguished from an experiment. A demonstration proposes to show a known truth, while an experiment is a search for truth. The demonstration are usually carried out by the Extension Specialists in collaboration with Extension Workers. When properly organized and successfully carried out, demonstration of farm or home practices create, in the farmer, confidence in the extension workers recommendations. The program to build confidence of workers and motivate the farmers is given considerable importance in the U.S.A.

APPENDIX V**ITINERARY OF THE U.S. AGRICULTURAL
RESEARCH TEAM MEMBERS IN PAKISTAN**

(March 13—April 7, 1968)

<i>Date.</i>	<i>Institutions.</i>	<i>Officials met.</i>
March 13, Wednesday.	Department of Plant Protec- tion, Karachi. Karachi.	Mr. HAFIZ MANZOOR ABBAS, Director, Department of Plant Protection and other officials. MR. ABDUL WAHID, T. I., Director of Research (Animal Husbandry), Agricultural Research Council. MR. A. RAHIM, Secretary, Agricultural Research Council.
	Pakistan Central Cotton Committee, Karachi.	MR. M. A. A. ANSARI, Director of Research, Pakistan Central Cotton Committee and other officials.
	Wool Test House, Karachi.	MR. A. M. CHOUDHURI, Agricultural Marketing and Statistical Adviser, Government of Pakistan.
	Karachi Fish Harbour, Karachi.	DR. M. R. QURESHI, Adviser, Fish Harbour and other officials.
March 14, Thursday.	Ministry of Agriculture & Works, Islamabad.	MR. S. A. M. KHAN, Secretary, Ministry of Agriculture and Works.
March 14, Thursday.	Cereal Diseases Research Station, Sunny Bank, Murree.	DR. S F. HASSAN, Senior Plant Pathologist.
March 15, Friday.	Agricultural Research Insti- tute, Tarnab, Peshawar.	DR. A. WAHHAB, T. I., Director and staff members.
March 16, Saturday.	Forest Research Institute, Peshawar. Peshawar.	MR. IHSANUR REHMAN KHAN, Director, and other officials. MR. FAZAL DAD KHAN, Director, Agriculture Department, Northern Region, Peshawar.
	Agriculture College, Peshawar	DR NOOR AHMAD, Principal, and staff members.
	Sugarcane Experiment Sta- tion, Mardan.	Sugarcane Specialist.

<i>Date</i>	<i>Institutions</i>	<i>Officials met</i>
		MR. OBAIDULLAH JAN, Sugarcane Specialist (Retired)
	Premier Sugar Mills, Mardan.	General Manager, Premier Sugar Mills.
March 18, Monday.	Lahore.	MR. MOHAMMAD MUSA, H.J., H.PK., Governor of West Pakistan.
	Department of Agriculture, West Pakistan, Lahore.	MR. AMIR AHMAD KHAN, S. K., Secretary, Agriculture Department, West Pakistan.
March 18, Monday.	Department of Agriculture, West Pakistan, Lahore.	DR. A. LATIF, Deputy Secretary, Agriculture Department.
	Soil Survey Project, Gulberg, Lahore.	CAPT. M. ASHFAQ, Joint Secretary (Animal Husbandry), Agriculture Department.
	Veterinary Research Institute.	DR. A. Q. M. B. KARIM, Director-General.
		DR. A. S. AKHTAR, Director, Veterinary Research Institute, Lahore.
		MR. SHAFI GILL, Director of Agriculture, Lahore Region, Lahore.
	Alfalah Building, The Mall, Lahore.	The US Agency for International Development officials.
March 19, Tuesday.	Agriculture University, Lyallpur.	DR. Z. A. HASHMI, Vice-Chancellor and other officials.
March 20, Wednesday.	Ayub Agriculture Research Institute, Risalewala, Lyallpur.	KHALIFA ANWAR HUSSAIN, Director & other officials.
March 21, Thursday.	College of Animal Husbandry, Lahore.	DR. M. MAQSOOD BUTT, Principal.
March 21, Thursday	West Regional Laboratory, PCSIR, Lahore	MR. M. ASLAM, Director, West Regional, Laboratory, PCSIR, Lahore.
	Irrigation Research Institute, Lahore	DR. MUSHTAQ AHMED, S. K., Director.

<i>Date.</i>	<i>Institutions.</i>	<i>Officials met.</i>
March 22, Friday	Agriculture Research Institute, Tandojam	MR. M. SIDDIQI, Director
	Agriculture College, Tandojam.	MR. A. G. PIRZADA, Principal.
	Atomic Energy Agricultural Research Centre, Tandojam	DR. M. SHAUKAT, Director, Atomic Energy Agricultural Research Centre.
		DR. M. SHARIF, Director of Agriculture, Hyderabad Region, Hyderabad.
	Karachi Fisherman's Cooperative Society, Karachi	MR. MAQSOOD AHMED BURNI, Deputy Director, Fisheries Department & Director Fishermen's Cooperative Society, Karachi.
March 24, Sunday.	East Pakistan Agricultural University, Mymensingh.	DR. S. D. CHOUDHURI, T.I., S.K. Vice-Chancellor and other officials.
March 25, Monday.	Pakistan Central Jute Committee.	DR. M. ISHAQUE, Director Jute Research, and other officials.
	Department of Agriculture, Eden Buildings, Ramna, Dacca.	MR. AMIRUL ISLAM, Director of Agriculture.
	-do-	MR. KAREEM IQBAL, T.P.K., T. CBR. Secretary, Department of Agriculture, East Pakistan.
	Atomic Energy Agricultural Research Centre, Ramna, Dacca.	DR. SHAMSUL HAQUE, Director.
March 26, Tuesday.	Eden Buildings, Ramna, Dacca.	MR. ALI ASGHAR, CSP, Chief Secretary, Government of East Pakistan.
	Agriculture Research Institute, Tejgaon, Dacca.	MR. I. H. KHAN, Additional Director of Agriculture (Research) & other officials.
	Directorate of Livestock Services, Eden Buildings, Ramna, Dacca.	MR. S. M. ALI, Director, Livestock Services, East Pakistan.
March 27, Wednesday.	Forest Research Laboratory, Chittagong.	Director-in-Charge, Forest Research Laboratory.
	Marine Fisheries Deptt., Chittagong.	MR. S. H. CHAUDHURY, Deputy Director.

<i>Date.</i>	<i>Institutions.</i>	<i>Officials met.</i>
March 28, Thursday.	Dacca. Foot and Mouth Disease Station, Nohakhali, Dacca. Department of Agriculture Eden Buildings, Ramna, Dacca.	THE WORLD BANK TEAM. MR. S. M. ALI, and other officials. MR. KAREEM IQBAL, T.Pk., T. CBR. Secretary, Department of Agriculture, East Pakistan.
March 29, Friday.	Islamabad.	MR. S. A. M. KHAN, CSP, Secretary, Ministry of Agriculture and Works.
April 1, Monday.	Rawalpindi.	MR. AMIR AHMAD KHAN, S.K., Secretary, Department of Agriculture, West Pakistan.
April 2, Tuesday.	President's House, Rawalpindi.	MR. S. FIDA HASSAN, HQA, S.Pk., Adviser to the President of Pakistan.
April 6, Saturday.	Report prepared in Rawalpindi March 30—April 5. Presented to Minister of Agriculture.	
April 7, Sunday.	American members of Team departed for the United States.	

APPENDIX VI

PAKISTAN AGRICULTURAL RESEARCH COUNCIL MEMORANDUM OF ASSOCIATION

- I. The name of the Council shall be the "Pakistan Agricultural Research Council".
- II. The registered office of the Council will be situated at the Headquarters of the Government of Pakistan.
- III. The objectives of the Council shall be:
 1. To serve as the technical arm of the Ministry of Agriculture and Works.
 2. To identify problem areas which need attention, develop and finance well-balanced and closely coordinated programs of agricultural research, on a long term basis.
 3. To establish research centres as and when necessary to fill in the gaps in the overall program of agricultural research.
 4. To organize seminars, symposia, conferences and group discussion of research workers to enable them to review progress and plant their work along profitable lines.
 5. To award scholarships or fellowships and training grants for subjects within the sphere of the Council to foster the upgrading of research personnel.
 6. To finance travelling of suitable research workers abroad to attend conferences and to visit research institutes and laboratories, where outstanding work in their respective fields is being conducted.
 7. To act as a clearing house of information and support the publication of results of research.
 8. To establish liaison with international organizations concerned with the activities of the Council.
 9. To establish or assist in establishing:
 - a) Libraries
 - b) Museums
 - c) Herbaria and
 - d) Plant Introduction Centres and Germ Plasm Banks.
 10. To maintain national registers for:
 - a) research workers in agriculture and allied fields.
 - b) research projects under way.
 11. To accept grants, fees, donations and endowments, and
 12. Perform any other functions which may be assigned to the Council by the Central Government.

IV. The following shall be members of the Council:

1. Chairman—Minister for Agriculture and Works, Government of Pakistan.
- 2-4. Vice-Chairmen:
 - Minister for Food and Agriculture, East Pakistan.
 - Minister for Food and Agriculture, West Pakistan.
 - Secretary, Ministry of Agriculture and Works, Government of Pakistan.
5. Director General, PARC.
6. Representative of Ministry of Agriculture & Works.
7. Secretary, Agriculture Department, West Pakistan.
8. Secretary, Agriculture Department, East Pakistan.
9. Vice-Chancellor, Agriculture University, West Pakistan.
10. Vice-Chancellor, Agriculture University, East Pakistan.
11. Director, Agriculture Research Institute, West Pakistan, (to be nominated by West Pakistan Government).
12. Joint Secretary, Animal Husbandry, West Pakistan.
13. Director, Livestock Services, East Pakistan.
14. Director of Agriculture, East Pakistan
15. Chief Conservator of Forests, East Pakistan.
16. Director, Marine Fisheries Department.
17. Director, Forest Research Institute, Peshawar.

**PROPOSED ORGANIZATIONAL CHART
FOR THE
AGRICULTURAL RESEARCH COUNCIL**

Chairman

(Minister for Agriculture & Works)
Ministry of Agri. & Works

Vice-Chairmen

1. Minister for Food & Agriculture, East Pakistan.
2. Minister for Food & Agriculture, West Pakistan.
3. Secretary to the Government of Pakistan, Ministry of Agriculture & Works

Director-General

Director of
Crop Husbandry

Director of
Soils, Irrigation
& Engineering

Director of
Agricultural
Economics &
Statistics

Director of
Animal
Husbandry

Director of
Forestry & Range
Management

Director of
Fisheries

Deputy Director
(Administration)

Deputy Director
(Finance)

Deputy Director
(Research
Information)

Deputy Director
(Library and
Publications)

- NOTE:
- 1 The Directors will have the necessary supporting staff of Deputy Directors and Technical Assistants. The posts should be filled on a permanent basis as and when Scientists with the requisite qualifications and experience become available.
 - 2 The Deputy Directors will have the necessary supporting clerical staff.

APPENDIX VII

THE RESEARCH GRADE EVALUATION SYSTEM OF THE USDA AGRICULTURAL RESEARCH SERVICE

The selection and promotion system for scientists in the U.S. Department of Agriculture is described in the publication entitled *Research Scientist Evaluation Plan*, Agricultural Research Service, U.S. Department of Agriculture, May 1965. The system is widely applied, across discipline lines, to all positions in basic and applied research.

The initiative of the USDA in devising the pattern for the scientists evaluation and promotion plan was prompted by the need "to recognize outstanding researchers and retain them as researchers". In past classification procedures a scientist could advance only to a certain grade level in his field of training and expertise, then was obliged to assume administrative duties to advance to higher posts.

The concept that scientists should be promoted as scientists, and on the basis of their capability and productivity proved workable in the USDA and in 1960 the plan was adopted, with some modification, by the U.S. Civil Service Commission for Government wide use.

In addition to the publication mentioned above, the *Research Grade—Evaluation Guide*, of the U.S. Civil Service Commission (TS-52) June 1964 describes in more detail the application of the system to a wide range of scientists.

The Mimeographed *Administration Memorandum 444.9* of the USDA Agricultural Research Service presents the purpose and procedures of the promotion plan for research scientists and research administrators.

Copies of the above publications are not available in sufficient number to include each copy of the joint Team report but may be obtained from the USDA Agricultural Research Service or the Civil Service Commission, Washington, D.C.

APPENDIX VIII

COORDINATED RESEARCH SCHEMES

Frequent reference has been made to "coordinated research schemes" in this report and it is recognized that there is limited familiarity in Pakistan with the organization and functioning of such schemes. It seems desirable, therefore, to point out the nature of the inter-disciplinary collaboration, the arrangements for coordinating leadership, and for participation of individual scientists and different research institutions involved in such projects or schemes.

THE INTER-ACTION OF SCIENTISTS FOR "INTER-DISCIPLINARY" RESEARCH

The common procedure for research in many universities and research institutions is for individual scientists to concentrate on studies within their own field of specialization. This limits effective application of science to the field of agriculture, in which many biological and physical as well as economic forces confront the farmer with a galaxy of problems which require continuous solution. A high yielding crop variety is of no value if it succumbs to a destructive disease. Recommendations for use of new pesticides have little merit if the cost of material exceeds the benefit in returns. Some of the specific contributions of the specialized scientific fields, and the "inter-relationships", may be considered as follows:—

The Plant Breeder-Geneticist is the biological engineer who changes the form and shape of the plant—its height, strength of straw, leaf morphology—as well as its responsiveness to length of day, to harsh environments, to length of growing season, and to fertilizers. He also can change the disease resistance, the grain color and the quality of the product.

In research on improvement of crop production so much depends upon the modification of the crop plant itself that the plant breeder commonly serves as the coordinating leader of joint, coordinated projects.

No individual scientist can develop the depth of knowledge of the potentials of the wide resources of germ plasm, the methods of selection and testing for given characteristics, and other details concerning the improvement of a given economic crop, without spending a long career—preferably a lifetime—working with a given crop. Therefore, in countries where an Economic Botanist attempts to serve as the plant breeder for many crops he is usually not productive for any of them. In modern crop improvement it is essential for a plant breeder to concentrate on a single crop, and to have many such plant breeders working on that crop throughout the country.

The need for continuity, to develop deep understandings of the characteristics of a given crop, has significance also with respect to the tendency of agricultural scientists in Pakistan and some other countries to shift frequently to new jobs for modest increases in salary. It is for this reason that special attention must be given to merit promotions to encourage scientists to stay within their given specialized fields.

The Plant Pathologist must understand the life history and the host-pathogen relationships of the many diseases which may attack a given crop under different environmental conditions. The major crop plants such as rice, cotton and wheat may have up to 20 or more diseases which attack them, of which three or four are usually of serious and continuing importance. The diseases differ. The control of the virus diseases of rice which are transmitted by leaf hoppers or other insects require special attention from a virologist. The bacterial blights and the destructive fungal blast disease have different characteristics and must receive precise attention from qualified scientists for their control.

This may appear to suggest excessive specialization within a given scientific field. But, as in the case of the Economic Botanist working on too many crops, generalization in plant pathology begets mediocrity. This is not acceptable when an epiphytotic of a single disease may destroy a total crop or a large proportion of a crop within a country.

The plant pathologist must work closely with the plant breeder since disease resistant plants provide the most effective control for most crops.

The Entomologist, as in the case of the plant breeder and pathologist, must know the insect pest and its relations with the host plant. Control of insects by breeding resistant plants is not common but is receiving increased attention. There are many methods for insect control, including modification of the environment by changing the time of planting of a crop to offset the normal life cycle of the pest and other similar measures. Parasites or predators, and other biological controls, are receiving increased attention. The most common practice is control by chemicals which vary in efficacy, cost, and amount of residue, and which require specific research on time, frequency and rate of application.

The Soil Scientist—Agronomist is concerned with the fertility level of the soil and the nutrition of the plant, including attention to minor elements. He studies moisture conservation in rain-fed areas, and water management for irrigated agriculture. Research on tillage includes seed bed preparation, cultivation and other methods for weed control. The time and rate of seeding, time and levels of fertilizer application, and the frequency and amounts of irrigation fall within this field of study.

It is essential that the plant breeder and agronomist collaborate closely. As an example, the fertilizer trials conducted for many countries in recent years do not furnish useable information today because of the development of the new wheat, rice and other crop varieties which are able to utilize much higher levels of fertilizer application to produce yields that are double to fourfold the yields previously obtained. Pakistan is experiencing this with Mexipak wheat and the IRRI rice varieties.

The Economist must also work closely with the agronomist to determine the costs and returns for fertilizers and for other inputs or practices in growing a given crop.

The Agricultural Engineer covers a wide range of functions—in the design and testing of tillage tools, pest control equipment, irrigation equipment, harvesters, etc. He works closely with the soil scientist in determining rates and placement of fertilizers, and with the entomologist in determining rates and place of application of pesticides.

There is a close linkage also with plant breeders. In the United States, for example, the harvesting of tomatoes was made much more efficient in recent years by the combined efforts of the plant breeder and the agricultural engineer. The plant breeder bred tomato plants with a compact shape and size, specific fruit display or location, and determinate fruiting habits which caused all fruits to ripen at a given time. The engineer, therefore, had a uniform type of plant or "fruit bearing structure" for which he designed an economical mechanical harvester.

The Economist gives attention to many elements in cost of production, an increasingly important factor as farmers in modern intensive agriculture buy improved seeds, larger amounts of fertilizers, pesticides and machines. The comparative advantage of different crops or crop combinations in multiple-cropping systems must be studied, together with market procedures and outlets. The Economist also gives research attention to policy questions as related to subsidies and other incentives, and to effectiveness of credit and marketing procedures and institutions.

There are, of course, other scientific disciplines which complement the above, such as the biochemist who is concerned with grain or product quality.

Much of the stagnation of agriculture in developing countries stems from the lack of close linkage or mutual attention to the reinforcing scientific disciplines. The team work of agricultural scientists from different research institutions, in coordinated research schemes, has been a major factor in agricultural improvement in the United States and other agricultural advanced nations, as explained in Chapter VI. This must be given greater emphasis in Pakistan as the nation moves into high-productivity agriculture.

RESEARCH INSTITUTES

The Research Institute is usually a laboratory, or a laboratory with field facilities, at a given location where scientists from the several disciplines collaborate in giving joint attention to research on a given problem. The commodity research institutes established by the British in Asia and Africa, as well as by the United States have been discussed in Chapter VI.

The research institutes effectively combine the efforts of different scientists on a given problem. In most cases, however, because of the concentration of personnel at a given location, the institutes do not have the broad outreach into the different agricultural regions or locations where crops are grown under varying environmental conditions.

The institute usually is designed to supply information or materials to be used as a *resource* in further adaptive research conducted by cooperating scientists who modify the basic innovations to suit specific growing conditions. The International Rice Research Institute is an example of a highly specialized, inter-disciplinary research center.

THE COORDINATED RESEARCH PROJECTS OR SCHEMES

The coordinated research projects or schemes for improvement of crops, or on specific problem areas, combine the attention of scientists from different disciplines, and provide for flexibility or mobility of research into the different environments covered by the scheme.

Usually a nucleus of key personnel, including a plant breeder, pathologist, agronomist, entomologist, etc., works together at a given location to develop basic or background research materials or "resources" similar to the functions of the research institute. Additional plant breeders, pathologists, etc., are located at research institutes or universities, throughout the region in which the particular crop is grown, to give special attention to the variations in environments, soil conditions, diseases or pest hazards. It is, of course, essential to study soil-plant relationships where the soils are. Similarly, this dispersal of research furnishes prompt information on the limits of adaptation of new hybrid combinations or of new tillage, fertilizer, or pest control practices over extensive geographic areas. The coordinated schemes involve not only a number of scientific disciplines but also many institutions or research locations.

The most efficient operation of a coordinated scheme is for the joint use of staff and facilities of the existing research institutes, universities, colleges or other organizations concerned with a given research problem.

In the United States a substantial part of the research of the U.S. Department of Agriculture Research Service is conducted in cooperation with the States, by locating USDA scientists in the State Agricultural Experiment Stations. This procedure has made it possible to conduct efficient research over wide geographical areas on all types of agricultural production problems, and to keep abreast of the pest and disease hazards which frequently break out in the different regions of the country.

Pakistan can easily develop similar coordinated schemes through the more effective collaboration of the agricultural research institutes, the agricultural universities, the colleges of agriculture, and such organizations as WAPDA, SCARP, etc.

The coordinated wheat scheme is developing along this line and furnishes an excellent pattern which should be followed for other commodities and problem fields, as recommended by the Team in Chapter VI.

Coordinating Leadership

Coordination requires *a certain degree of guidance* in the exchange of information and in focussing on high priority problems which should receive prompt attention. Coordination, therefore, is an action which is best handled through an individual who is not only a working and highly respected scientist, but who also appreciates that his function is not one of control but rather one of "cooperative guidance."

In addition to working actively in the research project, the coordinating leader is responsible for maintaining personal contact with his scientific colleagues in the different disciplines, for facilitating the interchange of research information within their respective fields and for assuring a continuing liaison between the participating scientists. This is done through periodic seminars, through the coordinator's assistance in guiding the planning of the total research program, and in assembling and reporting the data.

The most effective coordinated schemes involve participation of scientists of high calibre in all of the respective disciplines, and with opportunities for participating scientists to meet at least once annually to discuss research results and make plans for the further joint research.

The coordinating leadership may be handled by a scientist from any one of the disciplines. In crop improvement research this role has customarily fallen to the plant breeder since so much of the potential of increasing productivity depends upon the inherent characteristics of the plant, which the plant breeder-geneticist can manipulate or modify.

FLEXIBILITY AND SUPPORT

Mention has been made in Chapter VI of the importance of ample support and flexibility for the successful operation of a coordinated research scheme. It is essential that a project which is conducted with cooperative participation of many individuals at numerous locations be administered so that there is no failure to provide for the equipment, the supplies, or other resources when they are required by the research specialist. Delegation of authority for purchase of materials and for travel is essential. The scientist must be able to move to a distant field plot for observations on stage of plant growth, disease reaction, or pest outbreaks when notes for differential data can be taken. The scientist knows about the timeliness of such operations and usually cannot wait for specific decisions or sanctions by administrative officers which may require several weeks' time. Such delay can cause the losses of a full season of work if approval is delayed beyond the period when meaningful observations can be taken.

The heads of institutes where coordinated projects are being conducted must be in full agreement, at the beginning of the project, on the nature and extent of cooperation expected of their staff members. There should be such agreement on the amount of financial support, and on the time and extent of travel required, with a maximum delegation of authority to the cooperating staff members to pursue their role as required in the totally cooperative scheme.

The coordinated scheme approach requires a high degree of cooperation between scientists of different disciplines, and between different research institutions. This may be a departure from the strong tendency for individual research and for strong centralized control by directors or heads of research institutes, but the coordinated scheme approach holds great promise for rapid progress in increasing agricultural productivity in Pakistan if there is an individual and institutional willingness to use it.