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BANGLADESH AGRICULTURAL RESEARCH PROJECT PHASE II

TERMINAL REPORT TO THE BANGLADESH AGRICULTURAL RESEARCH COUNCIL

BY

WINROCK INTERNATIONAL
INSTITUTE FOR AGRICULTURAL DEVELOPMENT

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Winrock International
WINROCK INTERNATIONAL INSTITUTE FOR AGRICULTURAL DEVELOPMENT

Headquarters:
Petit Jean Mountain
Morrilton, Arkansas 72110, USA
Telephone (501) 727-5435
Telex 910-720-6616 WI HQ UD
DIALCOM 41:TCN400
FAX (501) 727-5242

March 9, 1988

Dr. M. Motlubor Rahman
Executive Vice-Chairman
Bangladesh Agricultural Research Council
Farm Gate
Dhaka 15, Bangladesh

Dear Dr. Rahman:

The Winrock International Institute of Agricultural Development is pleased to present the terminal report for the Agricultural Research Project - Phase II as provided by the terms of contract number 388-0051, dated 22 July 1981. Building on the achievements of the first phase of the project (1978-1981), ARP-II emphasized moving agricultural research activities into farmers' fields through an integrated farming systems approach.

The results of the project are very encouraging for Bangladesh both from the standpoint of improving research facilities and of developing the country's human capital. A wide range of national research programs, such as soil and pest management, irrigation, crop and livestock sciences, social sciences, maintenance, and information and communication were strengthened by the long-term technical assistance provided by the contract.

On behalf of Winrock International, I extend our appreciation for the opportunity to have been a part of this important work. Comments and inquiries from you or your associates about this final report can be sent direct to me.

Sincerely,

R D Havener

Robert D. Havener
President

cc. Priscilla Boughton, Chief of USAID Mission, Dhaka

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8. ANNEX: Bangladesh ARP-II Project Profile

1. EXECUTIVE SUMMARY

1.1 INTRODUCTION

The Agricultural Research Project - Phase II (ARP-II) was initiated in July 1981 as a continuation of ARP-I (June 1978 to July 1981). It was funded by the U.S. Agency for International Development (USAID). The Bangladesh Agricultural Research Council (BARC) represented the Government of Bangladesh (GOB). The International Agricultural Development Service (IADS) and its successor, Winrock International Institute for Agricultural Development, provided project planning and implementation services. ARP-II terminated December 1987.

ARP-I had focused on building facilities, infrastructure, and core staff, and developing multidisciplinary priority research. ARP-II was designed to use those facilities and personnel to achieve these goals:

- build capabilities to move agricultural research activities into farmers' fields
- develop a farming systems research (FSR) approach with core disciplines
- develop linkages among the agricultural research institutes to build a strong and relevant agricultural research system

1.2 ACTIVITIES AND ACHIEVEMENTS

The activities and achievements of ARP-II are described in sections 4 and 5 of this report while section 6 presents this information in tabular form.

Thirty-six long-term expatriate specialists devoted approximately 86 person-years to achieving the goals of ARP-II. Their efforts were supplemented by 190 short-term consultancies that provided expertise in specific areas.

Under ARP-II, Bangladesh researchers earned 8 out-of-country Ph.Ds and 22 M.S. degrees as well as 18 in-country Ph.Ds and 25 M.S. degrees. Seventy-four Bangladesh scientists attended overseas short-term courses and another 85 attended international conferences or participated in study tours. This training is a major achievement for strengthening the national agricultural research system of Bangladesh.

Over 135 short-term in-country training courses were attended by more than 3,100 participants. There were 64 workshops, seminars, and conferences for about 5,000 persons. This training measurably improved the technical and interinstitutional capabilities of the research system as well as strengthening extension-researcher-farmer linkages.

Many project activities directly focused on cropping or farming systems while others (such as water, soil, pest management, agronomy, crop

science, and livestock) concentrated on specific research components, which are the technical "nuts and bolts" of farming systems research.

To round out the project, funds were used for direct support of research projects in all aspects of the system throughout the country. Thirty-four contract research projects, usually with multidisciplinary and multi-institutional participation, were funded by ARP-II.

To support these agricultural research and development activities, a total of about US$2.67 million was spent on commodities ranging from transport and farm machinery to special fertilizers, laboratory instruments, computers, books, and journals.

There were 293 different publications (such as consultancy reports, research articles, newsletters, project reports, proceedings, brochures, and books) were produced, providing a well-documented record of ARP-II.

Coordinating the ARP-II activities was the executive vice chairman (EVC) of BARC who was responsible for project implementation. The contractor, Winrock International, worked with BARC to complete its responsibilities.

ARP-II funds were used to support long-term technical assistance in research systems management, farm development, maintenance, training, agricultural information and communication, farming systems, economics and social sciences, irrigation water management, agronomy, crop science, horticulture, livestock science, soil management, and pest management.

As is to be expected with such a large team of expatriate specialists from a wide range of disciplines who were working with a multitude of Bangladesh counterparts, not all components of ARP-II had the same levels of achievement. Some components were highly successful while others had only moderate accomplishments. However, all were able to make significant progress in reaching their specific program goals. These achievements are described in detail in section 4.

1.3 CONSTRAINTS

Many different constraints influenced the various components and individuals of ARP-II. These also are reported in sections 4 and 5. Four were common to virtually all disciplines and are mentioned here to support development of future projects.

- In many situations no Bangladesh counterparts were assigned or those persons were not appropriate for part or all of the specialists' tours of duty. This condition significantly reduced the institutionalization of project components.

- The Government of Bangladesh clearance procedures for overseas training severely restricted the development of the human resource base necessary to continue project objectives after termination of ARP-II. There were nearly 100 missed overseas training

opportunities during the span of the project. Near the end of ARP-II, steps to improve the system were taken by the Government of Bangladesh, but these were too late to affect the training program.

- The government's clearance procedures for allowing expatriate specialists and consultants to work in Bangladesh also resulted in many missed opportunities, caused considerable extra work for specialists, and compelled BARC to reschedule countless activities.

- The time between purchase and delivery of commodities often was unconscionably long as a result of both USAID and GOB regulations. This situation was further confounded by the distribution systems of the institutes once commodities were received. These difficulties delayed many research activities but were not as serious as the three constraints mentioned above.

1.4 CONCLUSIONS

ARP-II has had very positive short- and long-term effects on the national agricultural research system of Bangladesh. Virtually every agricultural research institute and person was influenced by one or another component of ARP-II.

Measuring the benefits of ARP-II is easy in some cases, while others are elusive if not impossible to evaluate. The positive and immediate impact of a new laboratory or computer facility designed and equipped through ARP-II funding is tangible and thus readily seen. It is much more difficult to measure changes of attitude or research focus of a junior scientist that were a result of consultations with a specialist, or of the effects of research-extension-farmers linkages developed through contract research, courses, workshops, and field days.

It is clear, however, that Winrock International fulfilled the requirements of the contract. The national agricultural research system of Bangladesh is strengthened as are the role and competency of BARC. The concept of a farming systems research was introduced, accepted, and being implemented in the last years of the project. Many research components of the various institutes were strengthened, thus injecting research information into farming systems research or were in the process of data collection and training of personnel for this task.

Each specialist, and in most cases their Bangladesh counterparts, stated the need for continued technical and financial assistance for each component activity. Specific suggestions are presented in section 5 on a case by case basis regarding future needs of the agricultural research system of Bangladesh. These recommendations can serve as a basis for future funding of activities by USAID and other donor agencies.

The accomplishments of ARP-II would not have been possible without the considerable effort and cooperation of many Bangladesh counterparts, scientists, and administrators. The important role of the executive vice chairman has been mentioned, but many others contributed to ARP-II, too. These include member-directors of BARC; directors-general of

research institutions; division heads, PSOs, SSOs, SOs in the research system; extensionists, farmers, and others. All accomplishments must be shared with these individuals. The cooperation of USAID personnel was of great benefit. Winrock International acknowledges the many contributions by these persons and countless others who were in some way a part of ARP-II.

2. INTRODUCTION

In July 1981, the U.S. Agency for International Development (USAID) initiated the Agricultural Research Project - Phase II (ARP-II) with the Bangladesh Agricultural Research Council (BARC) to strengthen the national agricultural research systems of Bangladesh.

This final report documents the accomplishments of Winrock International (and its predecessor, International Agricultural Development Service [IADS]) in fulfilling its contract with BARC to provide technical assistance support for this task. This report begins with a sketch of agricultural research in Bangladesh, then focuses on project objectives and implementation. There are detailed accounts of the human and financial resources devoted to the project, achievements by program area, human resources development, and suggestions for continued improvement and alleviating constraints to that development.

2.1 AGRICULTURAL RESEARCH SYSTEMS IN BANGLADESH

2.1.1 Bangladesh Farmers: Early Agricultural Researchers

Bangladesh farmers have long searched for better ways of growing their crops and livestock; they were the country's original agricultural scientists. For centuries they have watched skies and rivers, gaining intimate knowledge of the rains and floods that alternately are the life and destruction of their food supplies. They know the characteristics of their soils and their seeds. Through many generations of practical trial-and-error experiences, they have developed cropping patterns that make best use of their limited resources and varied management capabilities.

Today's agricultural research, however, requires skills and resources that are not readily available to individual farmers. These requirements have led to the development of national agricultural research systems such as now under way in Bangladesh. They use the tools of science to help farmers make management decisions for better use of the natural resources and inputs available to them.

2.1.2 Formal Agricultural Research in Bangladesh

Formal agricultural research in what is today Bangladesh began in 1880. On the recommendation of the Famine Commission, a Department of Agriculture was established under the Department of Land Records in Bengal. Systematic research on jute was started by the provincial government at the turn of the century. Planters, the tea trade, and several governmental units began tea research about the same time.

The Indian Department of Agriculture was established in 1905. Lord Curzon, the Viceroy of India, granted separate status to the Bengal Department of Agriculture the following year. Two years later rice research was started by the Department.

A nucleus agricultural research laboratory was established at Tejgaon in 1908 to serve the provinces of Bengal and Assam. A chemist was employed to develop sugarcane and tobacco trials, and to conduct manurial experiments. At about this time, a 403-acre experimental station known as the Dacca Farms, was set up. This was the predecessor of the Bangladesh Agricultural Research Institute (BARI) and other commodity specific research institutes. By 1925 the Farms had a staff of 17 scientists. Rice, jute, cotton, oilseeds, pulses, and sugarcane were the focus of research efforts.

Another important step was the formation in undivided India of the Imperial Council of Agricultural Research in 1929. This action was recommended by the Royal Commission on Agriculture, which served from 1926 to 1928. While agriculture was a provincial responsibility, the new Council gave nationwide coordination to the work at the central research institutes and at the state research centers.

Education played a crucial role in the Bangladesh agricultural research process. The nation has benefited from early and strong educational resources, beginning with the founding in 1938 of the Bengal Agricultural Institute. At the time, this was the only school for higher education in agriculture in the province. Today it is known as the Bangladesh Agricultural Institute, affiliated with the Bangladesh Agricultural University (BAU) and administered by BARI.

The worldwide economic depression of 1930 to 1940 severely reduced resources available for agricultural research, greatly restricting experimental work. Although tea research almost stopped, by the end of 1939 the research system had successfully developed and introduced improved varieties of rice, sugarcane, and jute. Again in 1942 and 1943 research came to a near standstill when the Japanese threatened to invade India through Bengal.

The end of the British Colonial period in 1947 caused the division of ICAR into the Indian Council of Agricultural Research (ICAR) and the Food and Agricultural Council of Pakistan. Both councils had similar purposes, to aid, promote, and coordinate agricultural research in their perspective countries.

Research institutes in jute, tea, and sugarcane were lost to India at the time of partition. Many scientists also left the country.

New research agencies devoted to jute and sugarcane were established in 1951 and continue as the Bangladesh Jute Research Institute (BJRI) and the Sugarcane Research and Training Institute (SRTI). However, jute research also has been conducted by various governmental ministries having responsibility for production, processing, and marketing of this important crop.

The Forest Research Institute was established in 1955. Another series of reorganizations occurred in the mid-1950s, leading to the establishment in 1957 of the Agriculture Research Institute under the Directorate of Agriculture (Research and Education).

The Tea Research Institute (TRI) was founded in 1958 to replace scientific facilities lost at the time of partition.

The Atomic Energy Agricultural Research Centre was established in Dacca in 1961 with assistance from the International Atomic Energy Agency.

In 1962, higher education in the agricultural sciences advanced substantially with the establishment at Mymensingh of what is now the Bangladesh Agricultural University. Major resources were devoted to building, equipping, and staffing this campus, which is now Bangladesh's primary training institution for agricultural scientists. BAU offers both undergraduate and graduate level degrees and also has a modest research program.

However, 1962 was also a year of major disruption for agricultural research as the Pakistan government acquired the experimental station lands at Dacca Farms. This became the site of the parliament house, an area now called Sher-e-Bangla Nagar. This was a severe blow to progress as Dacca Farms was the principal and because the province lacked a strong institutional base for agricultural research. Nearly a decade passed before scientists again had adequate lands for conducting their field experiments. A rice germplasm collection was lost that had taken 50 years to assemble.

In 1964, there was further reorganization in the national research program when the Pakistan Agricultural Research Council was formed from the Food and Agriculture Council.

Active cooperation with the newly created international research centers began in the mid-1960s. The International Rice Research Institute (IRRI) introduced the first high yielding varieties (HYV) of rice in 1965. Sugarcane varieties were imported for testing on mill farms and Virginia tobacco was introduced and quickly dominated this crop.

In the late 1960s scientists were able to start temporary rice breeding work on lands of the Savar Dairy Farm. The government purchased 650 acres of land near Joydebpur in 1966 as a replacement for the Dacca Farms and planning began to erect a modern agricultural research center. More than a decade passed before these facilities were in place.

In 1970, the East Pakistan Accelerated Rice Research Institute was established with major support by IRRI. About 165 acres of the Joydebpur site were designated for this new center, which soon became the Bangladesh Rice Research Institute (BRRI).

The months of turmoil generated by the struggle for the independence of Bangladesh were a difficult period for agricultural scientists. Not only were their personal lives disturbed but they also lost crucial scientific and agricultural equipment. Independence brought opportunities for a new start and a major reorganization for the research system.

Several key steps were started in 1973. The farmer provincial organizations took on national responsibilities. One of the most important developments was Presidential Order No. 32, issued April 5, 1973,

establishing the Bangladesh Agricultural Research Council as the national agency to coordinate agricultural research.

Bangladesh received its first HYVs of wheat in 1973, introduced by scientists of the International Center for Maize and Wheat Improvement (CIMMYT). Achievements of the wheat research team have been recognized by several national prizes.

In 1972, research work in atomic energy was reorganized under the Bangladesh Institute of Nuclear Agriculture (BINA). Three years later BINA moved to its own modern research center at Mymensingh, adjacent to the BAU campus. The Swedish International Development Agency (SIDA) provided funds for its construction and equipment.

The continuing development of research institutions led to further restructuring in 1976. The BARC Amendment, Ordinance LI (July 6) authorized the Council to coordinate and provide leadership to the national agricultural research system.

In August 1976, the Bangladesh Agricultural Research Institute became an autonomous institution after the dissolution of the Directorate of Agriculture (Research and Education).

By the late 1970s, formal organization of the agricultural research system was nearly complete. BARC, BARI, and BRRI were autonomous institutions; BJRI, SRTI, BINA, and TRI were semiautonomous organizations; and institutes or directorates had been set up in the Ministry of Agriculture for forestry, fisheries, and livestock.

Then began an active period of construction of facilities. Some of the older institutes had satisfactory buildings, laboratories, and lands. BRRI was one of the first to be housed in a new facility. Other major construction included the new research center for BARI at Joydebpur, plus BARI's four regional stations; and the headquarters of BARC at Farm Gate in Dhaka.

Financial support for these facilities was provided by the World Bank and USAID. Additional grants were made by other countries: Australia for the Sugarcane Research and Training Institute; Japan for the Citrus and Vegetable Research Centre of BARI; and Great Britain for the Tea Research Institute. More recent international support has been devoted to helping Bangladesh meet its national goals by making good use of these facilities.

The Institute of Post Graduate Studies in Agriculture (IPSA) was created as a part of BARI early in 1983. It is a graduate study institution located at Salna that offers degrees at master and doctorate levels.

The Ministry of Agriculture announced a further reorganization of the research system in mid-1983 which combined BARI, BRRI, BJRI, and BINA within BARC. Research in livestock production was given increased status by the creation of the Livestock Research Institute (LRI) by Ordinance No. XXVIII of 1984. While the agency is still in its infancy,

a master plan for systems research has been prepared and presented to the LRI Board of Governors for approval and initiation.

Up to 1985 the majority of agricultural research had been single-commodity-oriented, mostly on-station. Only limited cropping pattern research had been conducted on-farm since 1975. Coinciding with the creation of LRI, BARC has used World Bank funds and USAID/ARP-II technical assistance to foster cooperation among LRI, Fisheries Research Institute, Forestry Research Institute (FRI), and all the crops institutes to implement an integrated FSR program for the small private farms of Bangladesh. This program is in its early stages but the evidence suggests that previously unadopted high level technologies now are more likely to be adapted to fit the newly defined needs of farmers with limited landholdings.

The division in 1986 of the former Ministry of Agriculture into the Ministry of Agriculture and Forestry and the Ministry of Fisheries and Livestock emphasized the importance of fisheries and livestock. At the same time, implementing this change requires more effort to coordinate all disciplines in the FSR program.

2.2 ARP-II: RESEARCH BRIDGE TO FARMERS WITH LIMITED RESOURCES

The Bangladesh agricultural research system originated with the farmer as the first researcher, then evolved into the simple commodity or sole discipline research specialties on experiment stations. Today the system is moving back toward the farm. Specialists and farmers are working together to test and adapt new technologies on the farm after preliminary research station screening. This period of transition is essentially the point at which the ARP-II began in July 1981 with the signing of a contract between BARC and IADS, which now is part of Winrock International.

ARP-II promoted the development of agriculture in Bangladesh, primarily through a FSR and extension approach to develop and disseminate practical, well-adapted, advanced technology at the farmer level.

The FSR approach involves collaboration across disciplinary and institutional lines. It operates with a broadly based team examining farm-level constraints to production, then feeds this information back into the research system. New technologies are developed at the research stations and subsequently tested in the farmers' fields. It is then possible to extend this information with careful monitoring to assess its rate and mode of adoption, and to develop and test other improved technologies on a continuous basis to fit the dynamic nature of today's agriculture.

Although many new technologies can substantially increase production under controlled conditions, farmers' use of them may be limited by lack of credit, land, or markets, or by other factors such as cultural acceptance, government policies, and resource use priorities. The ARP-II was designed to bridge the gap between the needs of the small landowners and the availability of new technologies, most of which

originated from experiment station research in developed and developing countries.

ARP-I charted the approach by strengthening the functional capacity of BARI by building physical facilities, core staff, a priority research program, and multidisciplinary research projects. Budgetary support for research activities was provided by BARC as the coordinating body of the national agricultural research system. IADS administered ARP-I with BARC and BARI from June 1978 to July 1981. ARP-I provided nine resident expatriate specialists and 27 short-term consultants in addition to construction at headquarters and substations, transport, commodities, training, budgetary support for research, and international travel.

2.2.1 Project Organization and Responsibilities

The ARP-II contract involved USAID as the donor, Winrock International as supplier of the project planning and implementing services, and BARC as representative of the host government overseeing implementation of the project.

Project goals were to

- build capabilities to move agricultural research activities into farmers' fields where production problems could be better identified and solutions tested

- build strong, responsive core discipline research programs within a "farming systems research framework" to develop the new technologies to address production problems

- concentrate efforts to link different agricultural institutions into a research system relevant to achieving the country's agricultural development objectives

The project provided equipment, training, program development support, and high-level technical advisory assistance. This work led to some reorganization of institutes involved in agricultural research and reorientation of scientists, which is described in subsequent sections.

The project was organized as follows:

- The BARC executive vice chairman was responsible for overall implementation of the project and was assisted by the Winrock project supervisor.

- The project supervisor coordinated the specialists activities and provided the communication link between Winrock and BARC. A senior specialist served as deputy project supervisor to assist in these duties.

- Project specialists worked closely with BARC member-directors in their interinstitutional coordinating roles as well as with institute directors and scientists conducting research programs.

- When Bangladesh scientists were abroad for training, specialists often were asked to take major research responsibilities until this training was completed.

- Most of the specialists were assigned at BARC to work with BARC's member-directors. Ten specialist positions were assigned to BARI headquarters and its regional stations to take part in BARI's programs and to assist its administrative and research staff. The BARI-assigned positions were farm development specialist, associate production agronomists (4), entomologist, agronomist, horticulturist, plant pathologist, and soils specialist.

- Consultants were provided to assist FSR programs, research-extension linkages, and to strengthen BARC's capacity for agricultural research coordination.

- The project supervisor and specialists helped develop a "Five Year Master Plan of Action." This group also prepared annual work and financial plans in collaboration with BARC and other institutions involved in the project. These were submitted by July 31 of each year. Semiannual reports were prepared with details of major activities including progress, problem areas, and required actions.

- Quarterly meetings of a BARC-appointed project advisory committee were held to review progress, coordinate all project activities, and identify and remove all system constraints. The BARC EVC convened and chaired these meetings of representatives of BARC, the participating institutions, USAID, and the Winrock project supervisor.

- Two external and a final review were scheduled to coincide with the second, fourth, and final annual reporting periods. These reviews was to determine how well the implementation objectives were being accomplished. Similar internal reviews were conducted in alternate years.

2.2.2 Broad Program Areas

Component research studies were integrated in the ARP-II implementation strategy, with core research programs working within a farming systems research framework. The project focused on three broad program areas.

- Institutional coordination. Strengthening the role of BARC through technical assistance, training, and equipment support. Linkages between extension and research programs also were further developed.

- Core discipline development. Identifying specific research disciplines that could help solve practical problems found in the farming systems studies. These disciplines were then supported by the development of manpower, equipment, and logistical support, which allowed them to carry out research in farmers' fields as well as on research stations.

- Research support services. Strengthening the research program by reinforcing research station administration, financial management,

technical library services, communication, and data processing through technical assistance, training, equipment, and supplies.

In addition, project funds were used to mobilize existing research system resources to help solve problems related to achieving these goals.

Nine resource components provided by ARP-II were in two groups: one to provide support services to research programs and the other to support core disciplines in making improvements in specific farming systems.

The three components of the research support activities were research systems management, farming systems research (on-farm trials), and library and communication services. This group assisted in the coordinating and supporting a farming systems research/extension program.

- Research systems management provided an improved system for research management, planning coordination, implementation, and technical and financial monitoring.

- Farming systems research developed and implemented a comprehensive research effort that identified more productive uses of the limited resources available for the entire farming system.

- Library and communication services strengthened BARC and participating institutions' agricultural research information and communication services and expanded their libraries and documentation services.

The other group of six components focused on enhancing specific disciplinary activities were economic and social science, crop research, livestock research, soil management, water management, and pest management.

In July 1982 the project paper was amended to provide support to expand the water management program and to contribute to a consortium effort for a technical assistance and training program at the Bangladesh Rice Research Institute. Subsequently, other amendments were made to facilitate completion of planned activities, including the extension of the project to December 30, 1987.

3. OBJECTIVES AND IMPLEMENTATION

3.1 GENERAL APPROACH

The basic objective of ARP-II was to increase the effectiveness of agricultural research necessary to develop appropriate technology for Bangladesh farmers. Reaching this objective required close association between researchers and farmers and continued support for on-station single and multidisciplinary component research projects.

To strengthen the bridge between station component research and the farmers, the project created a farming systems research program linking experiment station researchers with field extensionists.

Fortunately, crop research in Bangladesh had taken some very positive steps in this direction by establishment of more than 17 substations throughout the country and initiating "On-farm Cropping Pattern Research" between 1975 and 1980. While that effort did not study the total farming system, it did initiate an interdisciplinary approach among crop production and socioeconomic scientists. Cropping pattern research continued in several institutes until about 1985, while others maintained essentially academic-level research on component single commodity technology. Most studies had been on-station, were single discipline, and academically oriented. Such research rarely was associated with economic production traits. Livestock, fisheries, homestead, and forestry research were little studied in relation to their effect on the total farming system or their specific interactions with crop production.

The FSR program was jointly promoted by several donors, including USAID, World Bank, and Ford Foundation. The livestock, fisheries, and forest research institutes had not started cooperative FSR with the crop institutes, though firm commitments were made by all institutes to form multidisciplinary teams on the FSR sites of the various institutes. For example, the Livestock Research Institute agreed to hire livestock scientific officers (SOs), provide them training in FSR and assign one to each FSR site team of the crop institutes. LRI also is committed to supervise the livestock SOs plus their agronomic teammates to facilitate livestock research. The crop institutes offered complete cooperation of their FSR teams to conduct livestock research within the total FSR projects.

3.2 PROJECT COMPONENTS/IMPLEMENTATION

3.2.1 Research Systems Management

BARC gives leadership to agricultural research coordination and planning for Bangladesh. Its mandate is to coordinate the national agricultural research systems by developing national research plans and in guiding the development and reviewing the annual plans of the institutes carrying out agricultural research. In addition, BARC had funds

available from USAID and IDA to contract for specific research studies. This provided a capacity to respond to research needs that fell outside the usual scope of the research institutions. For example, these funds were used to support high-priority research through the activities of several institutions.

Because of the breadth of BARC's activities, its small staff often could not be stretched to accomplish its goals. The project specialists helped BARC accomplish its goals by working with the member-directors and their staffs.

The Winrock International project supervisor supplemented the professional management capacity of the executive vice chairman to more effectively support the activities of the various member-directors.

The research management objective was to strengthen and expand research management, planning, coordination, implementation, and technical and financial monitoring whereby a national research system can function and perform effectively.

Implementation included work with BARC staff to develop

- managerial and planning skills to make the research system responsive to national goals, regional research priorities, and end-users (farmers)

- an inventory of research skills that can be continually assessed and maintained, with an appropriate personnel development program in place to meet requirements

- a financial system that can assure that funds are planned, allocated, and disbursed in a judicious and timely manner

- evaluation procedures to ensure interaction at all levels within the research system

3.2.2 Research Systems Administration

BARC's International Program Service Unit (IPSU) provides administrative support services to international donor projects. Its mandate is to develop a strong local capacity to efficiently handle logistic, accounting, fiscal management, office support, and commodity procurement functions. At times, IPSU was unable to provide the level of support required by ARP-II. Particularly difficult was the inadequate attention to housing logistics, financial disbursements, and budget planning.

Because of these and related restraints, most of these responsibilities were handled by the Winrock International administrative specialist and the more flexible local Winrock staff. However, the administrative specialist and the staff continued to work with IPSU and the member-director (administration and finance), primarily for training purposes and to facilitate needed actions.

3.2.3 Farm Development

The efficient management of farm equipment for development and maintenance of the agricultural research stations' networks is essential for the smooth conduct of research programs by station scientists. This includes land leveling, field layout, irrigation, drainage, and transportation.

The objective of this project component was to establish an effective system for managing station equipment and to facilitate the most effective research operation at BARI and other institutes.

Implementation required:

- establishing an efficient repair and maintenance unit at each experiment station and substation

- training personnel to conduct maintenance, field layout planning, irrigation scheduling, and to coordinate equipment uses to meet researchers' demands

- inventorying the equipment and spare parts

- stocking the unit with the most essential spare parts and demonstrating their use and management

3.2.4 Agricultural Information

Accurate and timely flow of information is crucial to maintenance of a research system and its linkages with training and extension. The project focused on library and information resources and communication of results and achievements, both high priority areas in Bangladesh.

This program area required technical assistance, training, and commodities to improve

- facilities for disseminating agricultural research information to key agencies and individuals in the agricultural sector

- basic communication materials for instructional programs related to agrotechnology transfer

- operational technical library and documentation services at the central and regional station levels for the national agricultural research network

- personnel trained and in place to perform tasks in technical communication and library and documentation

3.2.5 Maintenance

Research programs depend on quality, functioning scientific instruments and laboratory equipment. Many stations are well equipped due to various donor projects as well as government funds. This equipment is

of a variety of origins and brands. Frequently, it is nonfunctional because of lack of spare parts and of trained maintenance personnel and operators.

The project established a maintenance unit within BARC to help each of the institutes to improve their capacity to keep equipment functioning for smooth operation of all research programs. Implementation of the work included

- standardizing the type and brands of equipment purchased
- training personnel in the repair and maintenance of present equipment
- establishing an inventory of equipment and spare parts
- stocking the units with the most essential spare parts and demonstrating their use and management

3.2.6 Training

In agricultural research, human capital is often the most critical factor leading to high productivity and sustained program success. Project training activities ranged from in-country sabbatical leaves to functions directed at farmers, extensionists, and researchers. They included the more formal enhancement of human capital through postgraduate degrees as well as shortcourses and observation visits in the United States and Third World countries.

ARP-II provided financing and careful attention to developing a system for selecting candidates. The procedures now in place are working smoothly and the flow of candidates and resources is approaching the desired rate. Refinement of the manpower inventory is an ongoing but unfinished task; continuing assessment is being undertaken by BARC. Future training efforts will require increased staffing of the BARC training cell and greater freedom for people to leave Bangladesh for training purposes, including their participation in international workshops and observation/study tours. The recent governmental ruling allowing the executive vice chairman to approve overseas training for up to 3 months for all but senior positions, should help to alleviate this problem.

3.2.7 Farming Systems Research

The central feature of recent developments in the Bangladesh agricultural research system, and the key to ARP-II itself, is its strong orientation to the needs of small landholders. This new approach for Bangladesh developed a more productive food and fiber growing system that functions within the constraints and environments faced by the farmer.

This interdisciplinary thrust is called by the lofty banner of farming systems research.

The approach

- identifies farm production problems and more productive uses of the limited resources available of the entire farming system

- studies all aspects of the farming system by means of a multidisciplinary research effort

Within BARC and associated research institutes the FSR assistance involved creation of

- a functional field-trials division able to design and manage a farming systems program

- pilot activities for livestock interventions to the farming systems

- functional units of research/extension teams under the district-level technical committees (DTC)

- testing and improving of major crop technology and multilocation testing of improved practices

- training for research personnel in farming systems activities at research stations participating in collaborative research/extension farmer-research programs

3.2.8 Economics and Social Science

Research on economic and social science activities spans many levels in Bangladesh, ranging from farm management and production economics through marketing and price formation to the analysis of agricultural policy. BARC and project specialists concentrated on the first level, focusing on socioeconomic analysis in the farming systems research and on research resource allocation more generally, including attention to the distribution of benefits.

Implementation required developing

- fully operational units within the research system that are capable of providing socioeconomic inputs with economists and other social scientists trained in field-level farming systems programs

- special socioeconomic analysis of the major areas of agricultural development

- a centralized unit within the research system capable of processing social and economic data generated by the various agricultural research institutes

- policies and procedures for selecting research activities and programs that could produce technologies designed to be adopted in small farm agricultural systems

3.2.9 Crops Research

Bangladesh's capacity to conduct effective rice research is well established through the successful operation of BRRI. The emphasis in the BARC program was to develop a similar research system for other food crops and promote their integration into rice-dominated production patterns. The plan integrated activities ranging from plant breeding and fertilizer management to socioeconomic considerations.

The work strengthens research competency and productivity with selected food crops, especially wheat, maize, oilseeds, pulses, and root crops to develop improved disease resistant varieties of short duration and the kind of production technologies suitable to farming conditions in Bangladesh.

Implementation required

- personnel trained at the post-baccalaureate degree level to address key basic research problems in the food crops

- an operational multidisciplinary research effort involving the three key factors of soil/water, socioeconomics, and pest/weed management

- development of basic packages of proven technologies in food crop production for testing as part of a cropping systems program

3.2.10 Horticulture

The horticulture component of ARP-II was designed to help BARC, BARI, and the Horticultural Development Board scientists

- to improve research and seed production of local and exotic vegetables

- to develop intensive year-round vegetable production systems with emphasis on more intensive use of homestead plots and family labor

Implementation activities included

- initial emphasis on screening and testing new varieties

- improvement of postharvest technology, specifications of quality grading, and marketing research and development

- special studies, including analysis of the role of women in growing summer vegetable crops, or marketing, and of postharvest technology

3.2.11 Livestock

The BARC Livestock Division coordinates applied livestock research, dealing primarily with problem-solving investigations at the small farm level. BARC facilitates research implementation with all livestock related institutes, but does not implement research directly. Coordination has included helping direct BARC-controlled funds to

- support effective practical research projects

- support short- and long-term local and external training for senior and junior level personnel

- provide commodities, books, and equipment to accomplish applied research projects

BARC provides forums for multidisciplinary researchers to discuss on-farm problems and solutions and counsels the institutes in planning, implementation, analysis, and evaluation of research.

Implementation of ARP-II was designed to initiate a united research commitment to acquire data on livestock feed, health, husbandry, and production, and to develop an improved livestock technology component in farming systems. These operations included

- gathering basic information on livestock feed sources and making studies on feed practices in three pilot areas

- testing a minimum of four fodder crops in cropping systems research

- continuing studies of feed nutrition and farm wastes and by-products

- continuing studies of use, husbandry, and health of draft animals

- institution-building support for the LRI

3.2.12 Soil Management

The soil management component of ARP-II developed a multidisciplinary research program aimed at on-farm soil management, generally using a farming systems approach. It was designed to work with BARC and affiliated institutes

- to develop a sound database for preparing practical soil management recommendations for farmers covering fertilizer and manure use, tillage practices, use of biologically fixed nitrogen, and other soil management practices

- to develop a nationally coordinated soils management program involving the participation of all agricultural institutes engaged in soils research

- to develop the human resources necessary to continue the program after termination of ARP-II

Implementation procedures included

- training personnel in selected areas of soil management research and setting up of fully operational, coordinated units to respond to soil problems

- developing functional soils research programs in a minimum of four technical areas

- conducting specialized soils research projects dealing with cropping systems problems

- designing, purchasing, and installing an expanded soils diagnostic service from one central laboratory to serve an all-station network and eventually, individual farmers

3.2.13 Water Management

Irrigation is the key in many areas of Bangladesh to farmers increasing the number of crops grown on a field in a year and hence its overall productivity. A massive program of tubewell construction is underway to provide irrigation water, but a successful irrigation involves more than installing wells. Water management objectives include optimal coordination of research efforts to increase water use efficiency, to improve cost and energy efficiency of water lifting devices, and to expand irrigated command areas to grow more rice and other crops per unit of land. These are top-ranked national priorities in Bangladesh.

Under BARC leadership ARP-II implementation included

- support for developing an interinstitutional capacity to design, test, monitor and assess more efficient irrigation systems

- focusing efforts on water resources and professional development

- preparing documentation and publication of research results

- strengthening of research and extension linkages

3.2.14 Pest Management

Pests damage crops from the time seeds are planted until the harvest is consumed. The great losses sustained from pests and diseases make these important factors in determining a farmer's effective yield resulting from his other crop production activities.

The pest management program area developed technologies to protect field crops against pests and diseases, supplying technical assistance, human resources development, commodities, and contract research financing and assistance.

Implementation required

- developing, testing, and demonstrating methodologies to mitigate pest damage to crops

- providing functional research facilities and staff capabilities to monitor pest problems, test pest control technologies, and produce effective recommendations that are socially and economically acceptable to farmers

- training personnel to manage and implement research projects in pest management

- formulating a national pest control program with personnel who are capable of field level management and implementation

4. ACTIVITIES AND ACHIEVEMENTS

4.1 RESEARCH SYSTEMS MANAGEMENT

Ways to improve management within and of the Bangladesh agricultural research system remained a continued concern throughout ARP II. Ongoing and special project activities addressed one or more of these management issues: Enhancing the ability of BARC to coordinate the national research network; increasing the capability of the constituent research institutes to plan, conduct, and evaluate research programs and projects, and improving the relevance and efficiency of project activities in support of BARC and the individual institutes.

The project made significant progress on resolving or alleviating several management problems of BARC and the institutes. These included financial planning and management, development or a database to support a long-range program in development of human resources, and simplified procedures for encouraging and managing contract research.

Acquisition of 15 microcomputers in early 1985 facilitated development and installation of procedures for managing finances and personnel. In addition, many of the staff, technical and administrative, became proficient in the use of these microcomputers in their regular work.

BARC established a separate logistic support unit for the project staff, and a consultant reviewed and revised terms of reference for all long-term specialists. These actions contributed significantly to efficiencies in project performance and management.

BARC and project staff emphasized training, both formal and informal, with the human resource database increasing the ability to plan and target specific training activities. Special management-related workshops during the project period included four workshops, as follows: Research program evaluation, management of human resources, research management, and diffusion of technology. The first two were organized and conducted in cooperation with ISNAR, while the latter two were carried out through arrangements with the Office of International Cooperation and Development, USDA. Participants rated all workshops highly.

Over the project period, there were 34 consultant missions in research system management in addition to the following consultants in related fields: Training 3, agricultural information 10, and maintenance 2.

The heavy investment in consultants, training, and attention of the resident specialists is reflected in (a) increased competence in financial management, accounting, and clerical support services; (b) increased competence in planning and evaluation of research; (c) increased participation in contract research, and (d) workable system, with supporting database, for managing human resource development and utilization.

4.2 TECHNICAL SUPPORT SERVICES

4.2.1 Farm Development

ARP-II designated 36 person-months of technical assistance for a farm development specialist. This period was completed in July 1984 and was followed by a consultant from June to December 1984. Spare parts were received between January and June 1985, thus concluding this component of the project.

Farm Management Procedures Document

A farm management procedures document was prepared and distributed. It set forth in detail the day-to-day responsibilities of each section of the farm division, such as irrigation, farm machinery, labor, and farm inputs. Although this is not an official document, it is the present basis for operational procedures at the BARI headquarters and its use will be extended to the regional stations.

Land Leveling

The specialist trained local personnel to operate land leveling equipment, such as bulldozers, when trained personnel were not available. This enabled the leveling work to continue without delay. Primary land leveling was accomplished of over 150 acres of selected research plots throughout the various stations.

Farm Planning

Farm plans were developed for BARI substations at Pabna and Debiganj. The Sugar Industries Corporation was assisted with farm planning and development. Guidance was given for installing new equipment at BARI and the training staff in its use. The Regional Agricultural Research Station, Ishurdi, was assisted in preparing a land development plan for a 10-acre citrus and vegetable area which included land development, the extension of an existing irrigation system, a drainage system, and the internal layout for efficient farm operation.

Construction

A biogas plant (DANIDA design) was fabricated and installed at the BARI integrated family farming site. An oil ghani was installed for the Oil Seed Division and assistance given to construct a cold room for the wheat section. The director, support services, BARI, was assisted in continuous monitoring the progress of minor construction at the regional stations. Joint visits to the stations resulted in accelerating the construction works and improving the quality. Assistance also was provided in formulating the technical specifications and estimates for a fruit tree nursery at Hathazari, and for minor construction work at Jamalpur. A major irrigation network was completed at BARI, Joydebpur, consisting of a subsurface delivery system with risers at different field locations and a surface storage tank.

Commodities

The farm development specialist was involved in many commodity-oriented activities including a) assessing the development needs of stations in the BARI system that were not covered by earlier projects; b) assisting in preparing cost estimates for activities required for the World Bank-supported appraisal of research projects it funds; c) establishing farm support services at the BARI central and regional stations; and d) ordering and installing equipment such as seed drills, planters, pumping outfits, cultipackers, and corn planters at Joydebpur and some of the regional stations. Farm equipment worth US$49,000 was ordered, received, and distributed during 1984/1985.

Training

Periodic in-country training of engineers and technicians was conducted by the specialist. The majority of this was "on-the-job" training. The specialist and the coordinator of the integrated water management program organized and presented three short training programs at the regional station on water budgeting and efficient irrigation. The specialist organized a training program on farm operation and management at experiment stations in collaboration with Bangladesh Management Development Council, BARI, BRRI, and the agronomy specialist of Winrock International. A 1-week technical session on farm machinery management was conducted at the experiment stations. The specialist assisted BARI resource personnel in writing their training manual.

4.2.2 Maintenance

The maintenance operation of ARP-II was in two distinct phases. The initial phase was "transport and farm machinery" using an institute-based operation, while the latter phase was "laboratory electronic instrumentation" with a centrally based operation at BARC.

Transport and Farm Machinery

The center of operation for this phase was in the Repair and Maintenance Division of BARI, Joydebpur. A basic maintenance plan was developed and approved (with slight modifications) by Dr. M. M. Rahman, then director-general of BARI. The plan was written as a procedural document and was put into effect early in 1985. A second document dealing with the complete central stores operation was prepared, written, and approved. This plan was helpful in stocking spare parts and maintaining accountability and accurate records of repairs.

Central inventory. An inventory was made of field equipment and tools of the central repair facility at BARI. A central record of essential information concerning the equipment is on file, and the record of new spare parts received are added to the inventory. The repair record as well as maintenance costs on each piece of equipment are tabulated. These factors are taken into account for future purchases. The inventory was primarily of BARI operations.

Central purchasing of parts. Spare parts for the transportation fleet of Winrock were located in a bay at the BARC garage in June 1984. At BARI, Joydebpur, there was inadequate space to work on the vehicles, while farm implement parts were scattered about the agricultural engineering section. The present system at both BARC and BARI provides for bin storage allowing for quick location of parts. Accurate records are kept which are used to maintain an adequate stock of spare parts to keep the transportation fleet and farm machinery functioning at peak performance. Further, these records indicate the items having frequent "turn over" and so that restocking frequency can be estimated.

Construction of spare parts room at BARI, Joydebpur. There was a recognized need for a place to house farm and laboratory equipment spare parts. An existing building was modified for this purpose. The spare parts room at BARI has the capacity to hold up to 20,000 items. All spare parts were placed in this building after being properly cataloged, inventoried, and located for rapid recovery.

Construction and equipment of tool rooms at BARI, Joydebpur, and at the BARI regional stations at Hathazari, Ishurdi, Jamalpur, and Jessore. Tool rooms were constructed using a security-type design to house the tools and equipment required for maintenance of farm machinery at Joydebpur and the four regional stations. These rooms were each equipped with a complete set of tools required for these operations together with miscellaneous spare units for repair.

Library of operation and service manuals. A library of operational and service manuals was accumulated for the various farm machines. The manuals were cataloged and placed at the BARI, Joydebpur, installation. These manuals are a "must" for proper repair and maintenance operations. Not only do they give the specifications of the unit, but also the appropriate part number for ordering spare or replacement parts. It is impossible to do quality work without these manuals.

Training of repair personnel. The competence of personnel was constantly being upgraded in maintenance and shop store operations. This was accomplished by on-the-job training by the maintenance specialist. Training not only included basic use of the tools involved but also various diagnostic procedures for detecting problems with vehicles as well as preventive maintenance procedures.

Laboratory Electronic Instrumentation

Planned activity shifted within the TSS maintenance component with the change in the maintenance specialist in 1986. The majority of the new specialist's activities embraced establishment of repair and maintenance of electronic and mechanical laboratory equipment within the institutes associated with BARC. BARC became the central hub of operations for maintenance in the agricultural community of Bangladesh.

Central purchase of instrumentation with ARP-II funds. Aid was provided to project specialists in ordering laboratory equipment and instrumentation. During ordering, optional or additional parts would not be ordered. The maintenance specialist reviewed orders to assure

that all necessary components were included in the procurement allowing complete installations. This coordination virtually eliminated ordering errors.

Based on three consultancies and the parts required to make instruments of the institutes operational, spare parts were ordered for the various instruments in the laboratories of the national agricultural research system. The central electronics maintenance cell of BARC will send these parts to the institutes as needed, and until the institutes have their own repair facilities, will dispatch repair persons.

Construction of a central photocopy room at BARC. A central photocopy room was constructed at BARC in the annex. This houses equipment for meeting the copying requirements of BARC with the exception of training, the executive vice-chairman, and the library. The photocopy units were maintained by the maintenance specialist.

Construction of the BARC electronic maintenance workshop and equipping with proper test instruments. An electronic workshop with proper work space and storage for spare parts and records was constructed in the BARC annex. This unit is equipped with the elementary test equipment needed to troubleshoot and diagnose faulty electronic circuits. More sophisticated equipment can be added at a later date. This room will serve as the central facility for scientific maintenance.

Library of reference, operational, and service manuals. A library was established of reference books concerning electronics and electronic theory, as well as handbooks of specifications and operational and service manuals for electronic instrumentation in the laboratories of the institutes associated with BARC. These are stored in the central electronics workshop. Previously requested manuals continue to be delivered. These are available to the maintenance sections of the various institutes. A request for a manual is met by making and sending a photocopy of the original. Operational manuals in the original collection at BARI also are noted for possible use.

Training of personnel. A procedure for the installation of new instrumentation was being followed. At installation time, the major user of the instrument and a back-up person are requested to be present. The various parts and their use are explained while the unit is being assembled and installed. When installation is complete, the use, operational, and maintenance characteristics are explained. This training familiarizes the scientists with the unit and provides the confidence they need to successfully operate.

- Six courses in "Analytical Chemistry, Instrumentation and Maintenance" were presented for a total of 100 individuals.

- A text, "Analytical Chemistry, Instrumentation and Maintenance," was written by L. R. Mattick and Sam Portch as a reference manual and teaching aid.

- A course entitled "Basic Electricity and Electronics for Laboratory Equipment Maintenance and Repair" was presented to 12 people in 1987.

4.2.3 Training Division

The effectiveness of the agricultural research system depends to a large extent on the quality and quantity of its manpower Recognition of this fact is reflected in the amount of funds allocated in ARP-II to manpower development.

The training specialist was appointed in January 1982 and completed his assignment in January 1985. A consultant served from January to July 1985. A training specialist, appointed by the World Bank under UNDP funding, served from October 1985 to December 1987.

The start-up in training activities in 1981 and 1982 was gradual in terms of numbers of persons trained and courses achieved. The peak years were 1983 through 1985 with the apex in 1984. Training levels decreased in 1986-1987 as the project drew to a close.

During the period August 1982 to September 1987, a total of 75 training programs were developed and administered by Cornell University's International Agriculture Program according to the memorandum of agreement between Winrock International and Cornell University. This represents a total of 506 person-months of training. Despite many constraints, particularly in obtaining government orders to send persons overseas, the training division met project objectives as summarized in table 4.1 and provided in detail in tables 6.4 and 6.5.

Table 4.1. TSS/Training, July 1981 through April 1987.

	1981	1982	1983	1984	1985	1986	1987	Total
Out-of-country:								
Ph.D. students			7	1				8
M.S. students			12	10	1			23
Short-term training participants		12	27	54	19	15	5	132
Workshops presented				2	1	2	2	7
Study tours awarded				9	3	1		12
Conference/symposium attendees		3	14	17	6	8	1	49
Visits			3	5	2	4		14

In-country:								
Ph.D. students		1	4	6	5	2		18
M.S. students	1	1	7	11	8			28
Short-term training events		8	22	49	43	18	5	145
Persons attending		278	576	989	1,094	516	99	3,552
Workshops given		3		8	4	4	3	22
Persons attending		210		361	345	475	135	1,526
Conference/symposium presented			3	2	9	2		16
Persons attending			505	650	1,145	220		2,520
Seminars presented		2			8	1		11
Persons attending		176			382	15		583
Sabbatic leave awards			2	2	3	2		9
Total courses	1	30	101	175	112	59	16	494
Total persons	1	681	1,155	2,114	3,021	1,258	242	8,472

Overseas Training

Ph.D. Seven scholarships were awarded but eight are expected to be achieved, five from the United States, and three from the Philippines. One M.S. candidate in the United States earned a Ph.D. in 30 months. The last scholar should return in December 1988.

M.S. Twenty-four scholarships were awarded, seven in the United States, 13 in the Philippines, and three in Thailand. One person obtained a Ph.D., one returned with a diploma, and 22 M.S. degrees were awarded.

Short-term training. A total of 132 persons took courses ranging from 7 days to 9 months. Fifty-three persons were trained in the United States, 32 in the Philippines, 21 in Thailand, 12 in India, while others went to China, Sri Lanka, Malaysia, Swaziland, and Nigeria.

International conferences, study tours, and workshops. Forty-nine persons attended symposiums/conferences, 14 made visits, 12 had study tours, and 7 attended workshops. India was the most frequently visited with 27 participants. Others were Thailand 20, United States 14, Philippines 7, and Pakistan and Indonesia 5. Eleven other countries had one or two visitors.

Local Training

Ph.D. Eighteen scholarships were awarded. Two completed their programs and the remainder will finish by April 1990. Funding beyond December 1987 will come from nonproject sources.

M.S. Twenty-eight scholars started their studies and the awards were completed by September 1986.

Short-term training. A large variety of courses, 145 in all, were held in various parts of the country. They varied in length from 1 day to 1 year. There were a total of 3,452 trainees.

Conferences, seminars, and workshops. Sixteen conferences were held for 2,520 persons. Nine were held at BARC, five of which were international or national.

Eleven seminars were held for 583 persons. Ten were held at BARC of which three were international or national.

Twenty-two workshops were held for 1,481 persons. Thirteen were held at BARC, five at BARI, three at BJRI, and two at BRRI.

Sabbatic leave. Nine sabbatic leaves were awarded varying in duration from 6 to 12 months. Six were granted to staff of universities and three to staff of BARI and BINA.

Staff Strength

The Training Division was established as a cell in January 1982 with a staff of three people: director of training, a typist, and a peon; all working in one room. The staff now consists of eight persons: director of training, two SSOs, one training officer, one stenographer, one typist, and two peons. They are working from three rooms. The division is still under establishment.

Staff Skills

The director of training brought with him wide practical experience and extensive knowledge of training.

Training of the training cell staff in planning and administration was conducted on-the-job. One SSO attended an 8-week research management course and another a 6-week training of trainers course in the United States. One SSO, one training officer, and one typist received microcomputer training.

Training Procedures

In order to administer the planning and implementation of training, it was essential to establish guidelines and procedures to be followed. In early 1983 selection procedures for long-term scholarships were designed, approved, and put into operation. These were included in the "Handbook for Manpower Development" published in November 1983. This document covers long-term training procedures both abroad and in-country as well as short-term training, visits, conferences, workshops, and local sabbatic leave awards. This is now being updated to include changes in rules, regulations, and experience.

A comprehensive training plan was developed for participants going abroad and as well as those remaining in-country. It was improved each year enabling implementation and monitoring to proceed on a sound basis.

A manpower summary was carried out in 1983 which became a basis for planning future training. A wider and more detailed survey was started in late 1985 and a manpower inventory for all agricultural research institutes was computerized. An analysis of the data was made and the final draft prepared of a report highlighting many issues to be considered in the management of manpower along with a manpower development plan.

4.2.4. Agricultural Information

The need for strengthening agricultural research information and library resources, the communication of results and achievements, and linkages to the world research system was recognized from the beginning of the project. During the life of the project considerable progress was made in all areas of agricultural information serving the national agricultural research system.

Improvement of Communications Media

The quarterly newsletter, AGRESEARCH NEWS, introduced in 1983 by the communication specialist, was taken over in 1986 by the publications unit attached in BARC to NALDOC. It is a means of informing researchers of activities in other parts of the system, as well as serving agricultural leaders in Bangladesh and abroad.

The tenth anniversary of BARC in 1983 was marked by two publications: a book, "Agricultural Research in Bangladesh," which described the philosophy, strategy, and history of agricultural research, and how it contributed to national development, and by revision of the council's general information brochure, "This is BARC."

The opportunity was also taken to initiate a major series of meetings. The first National Symposium on Agricultural Research was conducted in December 1983, with over 300 participants, primarily agricultural scientists and researchers. The theme was "Ten Years of Agricultural Resarch in Bangladesh." The proceedings provided an important historical record of the major achievements of agricultural science in Bangladesh, and a guide to many challenges facing researchers during the second decade. It was intended that this should be but the first of a major series of symposia. The Second National Symposium of Agricultural Research was held at BARC in February 1986, with the theme "Agricultural Research for Food and Nutrition, Energy, and Employment." Publication of this proceedings is in progress by BARC.

BARC, International Service for National Agricultural Research (ISNAR), and Winrock collaborated on two international workshops on agricultural research management topics. The Regional Workshop on Research Program Evaluation was held in October 1984, and the International Workshop on the Management of Human Resources in Agricultural Research in March 1986. These two major events focused on BARC's activities in these fields, and enabled a fruitful exchange of ideas between practitioners in Bangladesh and elsewhere in the world. The proceedings are a valuable resource of thesetwo vital areas of research management.

Throughout the duration of the project numerous symposia and workshops were organized by BARC in collaboration with Winrock specialists. The communication specialist and information specialist were heavily involved in assisting with editing and arranging publication and distribution of the proceedings of the majority of these meetings.

Training in Communication and Information Techniques

Six training courses have been organized since 1984, including workshops for agricultural research journal editors, training courses in communication for research scientists, and workshops in video technology for photographers. In addition, the communication specialist also participated in training courses in library science organized by NALDOC. Over and above these specific training courses, on-the-job training took place during a number of consultancies and from the day-to-day work of the Winrock specialists.

Improvement of Library and Information Services

Considerable attention under ARP-II was given to the acquisition of books and journals for libraries at BARC and the various research institutes of the national system. Subscriptions to at least 100 journals were placed for the BARC library alone. These literature resources will strengthen the agricultural research capability in Bangladesh.

Until 1985 Bangladesh national input to FAO's AGRIS database was sent in written form via the Agricultural Information Bank for Asia (AIBA) in the Philippines. Following ARP-II consultants' visits in 1985 and 1986, a computer based system was installed and NALDOC began sending the Bangladesh AGRIS input to FAO on diskettes. Between June 1986 and June 1987 some 800 bibliographic records were sent. In addition, these records formed the basis of NALDOC's in-house database. As this database grows it will become the prime collection for information on agricultural research and development in Bangladesh.

The latest edition of the Bangladesh Agricultural Bibliography is being compiled by NALDOC from records added to the AGRIS database during 1985 and 1986. This was the first edition of the bibliography to have been processed and typeset using BARC's own computer facilities. Programs and procedures were written to enable NALDOC to carry out the computer operations so future bibliographies can be produced in this manner.

A similar technique was used to prepare the Irrigation and Water Management Bibliography, compiled in collaboration with the water management program area.

4.3 Farming Systems Research

The central thrust of ARP-II was to introduce and establish the farming systems concept into Bangladesh agricultural research. The farming systems specialist joined the project in September 1981. Together with BARC's member-director (crops and forestry) the specialist mapped out a program strengthening the National Coordinated Cropping Systems Program,

which had been initiated in 1980. This program involved eight institutes and had defined cropping systems sites and trials on farmers' fields at 24 locations. The specialist also was responsible for the assessing of cropping systems research being conducted at participating agricultural experiment stations.

By early 1983 there was a perceptible shift from a purely cropping systems to a farming systems philosophy. Much debate centered about the definition, scope, and usefulness of an integrated farming systems approach in Bangladesh. A production agronomist joined the project in March 1985 to more fully integrate the farming systems approach. He was assigned to the On-Farm Research Division (OFRD) of BARI and linked with the three associate production agronomists assigned to the BARI regional research stations. His main responsibility was to assist BARI in planning and implementing farming systems technology transfer. These five specialists assisted the research institutes in identifying technologies for incorporating in multilocation testing and pilot production programs based on results of cropping system trials as well as other trials on farmers' fields. They helped carry out multilocation testing at selected extrapolation areas to verify and validate technologies developed at different cropping/farming system sites, and helped conduct pil t production at selected sites to demonstrate the benefits of the new cropping pattern technologies. They also organized and conducted training for extension and production scientists engaged in multilocation testing and pilot production programs.

The farming systems specialist completed his asssignment early in 1986. He had successfully argued the need for transition to a comprehensive farming systems approach, helped to define farming systems in the context of Bangladesh and was a founder of the National Coordinated Farming Systems Research Committee.

The production agronomist at Joydebpur, and associate production agronomists at Ishurdi, Jamalpur, and Jessore carried the principles of farming systems to outlying research stations and to the farmers of Bangladesh.

4.3.1 Joydebpur

BARI Farming Systems Program (FSR)

The BARI FSR is one of the programs of the National Coordinated Farming Systems Research (NCFSR) under BARC. The BARI program was implemented by the On-Farm Research Division.

There were 11 FSR sites over the country under the BARI program representing different agroecological situations ranging from dryland in the dissected areas of Barind Rajshahi to the tidal prone and saline area of Barisal and Patuakhali. Ten FSR sites were in operation for 2 to 6 years. The Patuakhali site started in October 1986. FSR sites and their characteristics are given in table 4.2.

Table 4.2. Farming systems research sites operated by OFRD, BARI.

Site name	Year estab-blished	Agroecological situation	Present thrust
Kalikapur Ishurdi, Pabna	1982	Low rainfall (1,584 mm/yr) calcereous flood plain areas of the river Ganges, late start of monsoon	Rainfed & Irrigated System (CS) Homestead (HS) & Livestock (LS)
Narhatta, Bogra	1983	Moderate rainfall (1,756 mm/yr) moderately permeable clay loam medium highland	Rainfed & Irrigated CS, HS, & LS
Saroil, Barind	1983	Low rainfall (1,400 mm/yr) moderately permeable highland dissected barind soil	Dry Land Farming, HS, LS
Janokinathpur, Mithapukor, Rangpur	1983	Moderately high rainfall (2,200 mm) area, Tista silt loam high & medium highland soil	Rainfed CS, LS, & HS
Panchlia, Serajganj	1985	Moderate rainfall area with Ganges & Jamuna floodplain medium highland & medium low land	Irrigated rainfed CS, LS, & HS
Laherikanda, Jamalpur	1983	Moderately high rainfall (2,250 mm) area & Jamuna floodplain high & medium highland soils	Irrigated rainfed CS, LS, & HS
Palima, Kalihati, Tangail	1984	Moderate rainfall, Jamuna floodplain medium high and medium low land	Irrigated rainfed CS, LS, & HS
Bagherpara, Jessore	1980	Low rainfall, calcerious Ganges, floodplain, highland & medium highland soils	Irrigated rainfed CS, LS, & HS
Amirabad, Barisal	1985	Moderately high rainfall, tidally flooded nonsaline & saline areas	Irrigated rainfed CS, LS, & HS
Badarpur, Patuakhali	1986	Moderately high rainfall, tidally flooded saline & nonsaline areas	Rainfed CS with particular emphasis to salinity problem, HS, LS

Hathazari	1980	Moderately high rainfall representing both plain and valley land areas	Rainfed & Irrigated, CS, HS, & LS

The early emphasis of farming systems research in Bangladesh was on cropping systems. Research studies were done specifically on cropping patterns and crop component technologies. The shift from cropping systems to a more comprehensive farming systems approach necessitated a change in strategy and methodology. The FSR site staff used insights and mapping in the preliminary description of sites and their extrapolation areas. Case studies were used to describe and understand the whole farming systems.

Development of Cropping Pattern Technology

Cropping pattern research in the different BARI sites resulted in the development and improvement of location specific cropping patterns and management practices. Technologies developed were specific for the location and its extrapolation areas. There were 11 improved cropping pattern technologies developed at five FSR sites which were under multilocation testing in 21 extrapolation areas (table 4.3). Seven of the cropping pattern technologies were in pilot production programs in Jamalpur, Hathazari, Ishurdi, and Rangpur (table 4.4).

Table 4.3. Multilocation test cropping patterns (1986-1987) under OFRD, BARI.

Region	Cropping pattern	MLT sites
Region 1		
(Ishsurdi FSR)	B.Aus-fallow-lentil+mustard	Pabna, Chatmohar, Sujanagar
	Maize+mungbean-fallow-wheat	Pabna, Chatmohar, Kashinathpur
	Maize-t.aman-potato	Kashinathpur, Chatmohar, Pabna
	Pointedgourd-SM-potato+ garlic+pointedgourd	Lalmonirhat, Nilphamari,Saibandha
(Rangpur FSR)	Mungbean-t.aman-wheat	Lalmonirhat, Nilphamari, Saibandha
Region 2		
(Jamalpur FSR)	T.aus - t.aman - wheat (BR-14) (BR-11) (Kanchan)	Melandha, Sherpur
	Fallow - t.aman - boro (BR-11) (Pajan)	Melandha, Sherpur, Kandua, Netrokona

Region 3 (Jamalpur FSR)	B.aus - t.aman - potato (Local) (BR-11) (Cardinal)	Chougacha, Keshabpur, Jhenaidah, Sailkupa, Magura, Narail
	B.aus - fallow - mustard (Hashikalmi) (SS-75)	Kalaroa
Region 4 (Hathazari FSR)	Maize - t.aman - potato (Barnali) (BR-11) (Cardinal)	Satkania, Patya, Fatikchari
	T.Aus - t.aman - fallow (Chandina) (BR-11)	Fatikchari, Satkania, Patiya

Table 4.4. Cropping patterns under pilot production program (1986-1987) OFRD, BARI.

Cropping pattern	Situation	Year initiated	Location
Fallow-t.aman-boro	Irrigated	Rabi 1986	Laharixanda, Jamalpur
T.aus-t.aman-fallow	Rainfed	Kharif 1986	Hathazari, Chittagong
T.aman-mustard-boro	Irrigated	Rabi 1986	Hathazari, Chittagong
Pointedgourd-green manure-potato+garlic+ pointedgourd	Rainfed	Kharif 1987	Jonakinathpur, Rangpur
Mungbean-(GM/GR)- t.aman-wheat	Rainfed	Kharif 1987	Jonakinathpur, Rangpur
B.aus-fallow-lentil+ mustard	Rainfed	Kharif 1987	Kalikapur, Ishurdi, Pabna
Maize+mungbean-fallow- wheat	Rainfed	Kharif 1987	Kalikapur, Ishurdi, Pabna

Multilocation Testing Program (MLT)

Multilocation testing and extrapolation of improved cropping patterns was initiated at Ishurdi, Jamalpur, Jessore, Hathazari, and Rangpur. Eleven improved cropping patterns were tested in 210 locations of the 22 upazillas (see table 4.3). The OFRD of BARI published an MLT guideline incorporating cropping pattern technologies developed at its FSR sites.

A Memorandum of Agreement between BARI and the Directorate of Agricultural Extension (DAE) was signed June 1, 1985 for the participation of the subject matter officers (SMOs) as the implementing agents of the MLT program. The agreement strengthened researcher-

extension linkages, making possible extension's participation in the orderly implementation of the MLT.

Pilot Production Program (PPP)

Pilot production programs were initially launched by OFRD/BARI and the DAE at two FSR sites, Jamalpur and Hathazari. Ishurdi and Rangpur started pilot production programs in the kharif season 1987.

Two cropping patterns (t.aus (rice) - t.aman (rice) fallow under rainfed and t.aman (rice) - mustard - boro (rice) under irrigated condition) were tested at Hathazari beginning in the Aus season 1986. The name of the program was "Sufala Hathazari" (Bountiful Hathazari).

Jamalpur had the pattern t.aus (rice) - boro (rice) fallow under irrigated condition. It was initiated in the aman season 1986. The program was called "Mukta - Pajam Uthpadan Prokolpo" (Mukta - Pajam Production Program).

Ishurdi and Rangpur each had two cropping patterns for their pilot program. They were:

- Ishurdi: B.aus - fallow - lentil + mustard
  Maize + mungbean - fallow - wheat

- Rangpur: Pointedgourd - green manure - potato + garlic + pointedgourd
  Mungbean - t.aman - wheat

The pilot production programs at Ishurdi and Rangpur were initiated in the kharif season 1987.

A guideline was prepared for planning, organizing, and implementing pilot production programs for the sites that initiated pilot programs as well as for use of other institutes in the NCFSR project who will initiate their own programs.

The pilot production programs were implemented by extension personnel and assisted by FSR site staff and research scientists. A total of 100 acres covering six blocks were in the production program in Jamalpur; 70 were planted to the recommended variety, BR-11 and 30 acres were planted to Pajam and the local variety, Bini. There were 151 farmer participants in the program. The average yield obtained in the production program was 3.45 t/ha which was only .38 t/ha less than the pattern trial plots.

In Hathazari there were 30 acres t.aus established in 6 blocks in the rainfed area. Due to early drought 15 acres failed. The average yield was 2.43 t/ha. The t.aman was established in the same area. The yield was 2.67 t/ha. In irrigated areas, 40 acres of t.aman and boro were planted in the pilot area. The average yield was 3.89 t/ha and 4.54 t/ha, respectively.

Due to untimely rain only 4 acres of mustard was established instead of the planned 42.65 acres. The average yield of the crop was 0.72 t/ha.

Homestead Production and Utilization Systems

Several case studies were made to describe and fully understand the homestead production and utilization systems. Women scientists from different divisions of BARI assisted OFRD in developing case studies through which the role of women was also analyzed.

A collaborative study is now underway with the Women's Desk of the Ministry of Agriculture conducted by the lady block supervisors of the DAE.

4.3.2 Jamalpur

Activities at the FSR site at Laherikanda, Jamalpur, commenced in June 1983 with a benchmark survey. Studies on cropping systems also were initiated. The benchmark survey, completed in April 1984, reported the household, landholding, livestock, and population characteristics on a farmer category basis. It also described rainfall, land classes and soil characteristics of the site; ascertained cropping patterns and intensities; and described basic socioeconomic factors and pinpointed constraints to crop production.

Site organization, establishment of an office, and appointment of a site coordinator at the senior scientific officer (SSO) level, two scientific officers (SO) for agronomy and agricultural economics, and fieldmen (now designated junior scientific assistants) took place. All results of surveys and investigations up to kharif II 1986 were published in a benchmark survey report and in biannual reports of the Jamalpur On-Farm Research Division.

Out of several cropping patterns tested, the t.aman (BR-11) - boro (Pajam), and the t.aman (BR-11) - wheat (Ananda or Kanchan) - t.aus (Purbachi) patterns, were found to be agronomically feasible and economically viable. The former pattern was being further evaluated at MLT sites at Sherpur and Melandah, and the pilot production (PP) site at Laherikanda. The latter pattern was being evaluated at the MLT sites at Sherpur and Melandah. The MLT programs commenced boro and the PP program in aman 1986.

Another cropping pattern, t.aman (BR-11) - mustard (Tori-7) - boro (Pajam) under investigation at the FSR site, was being voluntarily adopted by farmers at the site. The diffusion rate is yet to be ascertained.

A significant thrust in moving toward the farming systems approach was undertaking studies related to livestock and to livestock and homestead crop linkages. The study revealed the extent of compatibility of homestead crops and trees with livestock. The target homestead vegetable crops, trees and livestock genera, and the aspects of research to be undertaken with these farming systems components were determined.

Priority was given in the livestock component to nutrition and veterinary care when relating to cattle and poultry. Studies began in 1986 on feeding urea-treated straw to lactating cows. Urea-treated straw increases digestability, voluntary intake, and crude protein content of straw. Straw accounts for 30% to 90% of all cattle feed in Bangladesh. The effect of urea-enriched straw on milk yield was quickly evident and had an immediate impact on the farmer. These studies were the first objective and statistically designed investigations at any FSR site in Bangladesh which related to urea-treated straw.

The objectives of the Laherikanda FSR site were first discussed with farmers and extensionists taking into consideration soils, climate, water resources, land classes, existing cropping patterns, livestock situation and socioeconomic aspects, as well as constraints and potentialities of the extrapolation area. The objectives were finalized in early 1987.

Twenty-one case studies were made in 1986 at the Laherikanda FSR site to get an in-depth understanding of farming systems activities of marginal and landless farmers. Emphasis on all aspects of FSR was directed at landless and marginal farmers with poor resources.

During the period 1983 to 1987, socioeconomic studies were completed on farm resources, fertilizer price analysis, livestock enterprises, cash flow, employment trends, farm income and expenditure, and whole farm monitoring.

A part of the Laherikanda FSR site falls within the Jamalpur Integrated Irrigation Command Area Development Project (IICADP). IICADP activities were coordinated with the FSR team. The SO (agricultural engineering) of the IICADP was a member of the FSR team.

Studies were initiated and in progress related to water management of major crops and cropping patterns, pump efficiency, pump maintenance, channel alignment, channel construction, and water distribution.

The associate production agronomist actively participated in the biannual research station and OFRD headquarters internal review workshop, regional technical committee meetings held prior to each cropping season, monthly extension impact point workshops, monthly district technical committee meetings, and field days. The workshops were to evaluate and review research and extension activities, and decide on priorities and strategies.

The associate production agronomist continually assisted on-station and on-farm scientists to plan, execute, and report investigations. This enabled them to make rapid evaluations of research findings and expedited the transfer of outstanding technologies to farmers, or for on-farm or extension evaluation. Priority was given to highlighting on-farm constraints so that on-station scientists could focus their studies on solving these problems.

The extension-research linkage gradually was strengthened. Since 1986, extensionists were more involved in the decision-making process from

formulating research objectives to evaluating research findings at FSR sites, and ultimately playing a major role in MLT and PP programs. Special field days were being held at the FSR sites for extensionists in addition to the usual research station field days and workshops.

Farmer participation in planning, investigating, and evaluating were given the highest priority. A high degree of direct interaction with farmers was achieved.

The associate protection agronomist organized monthly seminars and colloquia at the Regional Agriculture Research Station (RARS), Jamalpur. ARP-II specialists were the chief speakers at some of these meetings. There were evaluations of okra, summer tomato, sesame, sweet potato, soybean, and papaya seed acquisitions made possible by the specialist. Segregating populations obtained from true sweet potato seed, and summer tomato varieties seem to hold promise. The associate production agronomist contributed substantially to the development of library, laboratory, and other facilities.

Papers presented at important national and international seminars were as follows:

Second National Symposium on Agricultural Research, BARC, Dhaka, February 11-13, 1986:

- M. Rahman, SSO. Improved cropping systems tested at the Jamalpur farming systems research site.

- S. Alam, SO. Cash Flow and labor employment trends at the Jamalpur farming systems site.

- M. A. Rahman, SSO. Management of mungbean following rice under rainfed conditions.

Farming Systems Research and Extension Symposium, Kansas State University, October 5-8, 1986:

- M. Rahman, S. Alam, and N. Vignarajah. Homestead and homestead crop linkages with livestock at the Jamalpur farming systems research site.

4.3.3. Ishurdi

The number of on-station experiments at RARS/Ishurdi increased from 100 in 1982-1983 to 226 in 1986-1987. The research approach was on a farming system basis rather than component research only. Similarly, the number of on-farm experiments increased from 28 in 1982-1983 to 112 in 1986-1987 in Ishurdi. Confidence as well as competence of the local staff showed continued growth.

Internal review workshops were conducted twice a year with 100 to 125 participating researchers and extension officers. These reviews were an opportunity for frank, open dialogue among scientists and extensionists to improve the system.

Since 1984, annual interinstitutional workshops on farming systems and other related topics also were organized which increased the overall number of participants to 395 a year.

Extension and Research Linkage

Monthly impact point workshops for senior extension officers working in collaboration with senior research scientists were held with 60-80 persons taking part. Due to the subject matter specialists increased participation in these workshops they were increased to twice monthly since 1985, one workshop in the Rajshahi region and the other in the Rangpur region. The number of persons attending increased from 725 in 1982-1983 to 1,525 in 1986-1987.

Field Days Held

Year	No. of field days	No. of participants
1982-1983	8	975
1983-1984	9	1,200
1984-1985	10	1,675
1985-1986	15	2,125
1986-1987	17	2,685

Most participants were farmers and extension workers. Field days also are being organized in farming systems and multilocation testing sites.

Farming Systems Achievements

Cropping systems research was initiated at Kalikapur, Ishurdi, Bogra, Rajshahi, and Janokinathpur in 1981, and at Serajgonj in 1984. These locations were converted to FSR sites in 1985. Six site experiments on component technology research were initiated in 1981 and increased to 28 in 1986 at Kalikapur. Similarly, three cropping pattern testings were initiated in 1983 and increased to 11 in 1986. These included participation by landless families and involved women, children, and the elderly members of the family.

The homestead vegetable gardening program was initiated with 32 farmers in 1985 and increased to 40 in 1986.

Special purpose surveys were started in 1982 with 17 farmers taking part in the first course. Due to the expansion of activities included in the surveys, the number of courses increased to six in 1986 with 486 farmers participating.

Livestock production and utilization surveys were conducted in a shift towards farming systems research. Four cropping patterns were recommended for the multilocation testing site at Kalikapur and two patterns for Rangpur. Personnel from the Kalikapur site led the way with their activities, giving guidance and becoming a training ground for other FSR sites. Eventually in 1986 Kalikapur was judged the best site in the BARI system.

Publications

There was only 1 publication in 1982-1983, this number was increased to 5 in 1983-1984, 6 in 1984-1985, and 10 in 1985-1986. The skills of scientists were developed in the data collection and scientific report writing. In the past, publication of the RARS annual reports was 3 to 4 years behind; now publication is up to date.

Transfer of Technology

Transfer of technology was accomplished through dissemination of technical findings at internal review workshops, farmers field days, impact point workshops, and training of extension personnel and farmers. Four extension and research bulletins were published for fast dissemination of production information. Detailed technical information was given to subject matter specialists by producing 30 special technical papers. At the farming systems research site at Kalikapur, a modern variety of rice was grown in 100 m^2 in 1982. Now 90% of the transplanted aman is the modern variety. Similarly 80% of the mustard grown is the improved variety SS-75. Sunflower is grown on 7 ha. Maize has attracted the attention of area farmers. The adoption of technology also was encouraging at other farming systems research and multilocation testing sites.

SRTI - Components

Farming systems research at the Sugar Research and Training Institute, Ishurdi, was strengthened by training and orientation activities. One new site at Joydebpur and another at Thakurgaon was organized in 1985.

Sugarcane and potato intercropping was recommended for multilocation testing.

4.3.4 Jessore

Research Review

The first review of the RARS/Jessore was held in June 1982. All scientific officers prepared reports of their 1980-1981 projects. Thirty-six reports were presented by the scientific officers during the workshop. Attending were senior scientists of BARI (Joydebpur) and officers of the DAE from the Jessore region. The workshop was an opportunity for local scientists to learn how to prepare research reports (analysis and interpretation of data and scientific writing) and subsequently to present their papers before an audience. Prior to this, scientific officers from regional stations submitted their research data to the principal investigator or head of division at BARI, Joydebpur, for analysis, interpretation, and report writing.

There are now two types of research review workshops in the OFRD at BARI. One, an internal review, deals with regional research and extension activities and is conducted at the respective RARS. The other is the OFRD national research review where all regional research results are presented to BARI headquarters staff. These reviews are held twice

yearly, one during January for kharif I and II research results, the other in July for the rabi season.

At the end of each internal review participants are divided into commodity groups to discuss findings of the reports. They then identify related or new research projects which should provide solutions to the regional crop production problems. Research proposals are prepared for these new projects and presented for approval at the OFRD national research review.

There were 13 research review workshops completed during the reporting period, as shown in activities table 6.5.4.

Other workshops included:

- explaining the roles of subject matter officers (SMO), field assistants (FA) and field men (FM) at the MLT sites

- discussing with progressive farmers the improved cultural practices used for growing the major crops of the region

- defining roles of the site coordinator and other members of the FSR site team

- defining the scope and methodologies best adapted to a farming systems research approach

- explaining the contents of a survey questionnaire

The associate production agronomist gave major attention to these workshops, seminars, and other training activities:

- assisted with data compilation, analysis, and interpretation

- assisted with writing research reports

- assisted with the organization of the internal review workshops

- wrote the proceedings of internal workshops and circulated them to the participants and BARI authorities

Research Planning

There was a remarkable increase in the number of experiments in the Jessore and Barisal regions between 1980 and 1987. The number of experiments during 1980-1981 was 36, by 1983-1984 it increased to 66, and in 1986-1987 rose to 192. This was an 83% increase from 1980-1981 to 1983-1984 and a 191% increase from 1983-1984 to 1986-1987. These raises were most significant in wheat, pulses, vegetables, minor cereals, oilseeds, and the socioeconomic and agroeconomic aspects of FSR.

This build-up of experiments from 1984 to project termination resulted from three major factors: merger of the BARI cropping systems research,

extension, and research project, and soil fertility sections into the OFRD; creation of commodity improvement programs; and upgrading of cropping systems research to FSR. Regional planning and a more critical identification of priorities greatly contributed to the increase in research activity between 1980-1981 and 1983-1984, thus contributed to the improved focus and quality of research.

The principal contributions of the associate production agronomist to research planning were:

- working with local scientists to identify new research projects to increase crop production and improve land use

- working with local scientists to write research proposals, specify objectives, and suggest treatments for testing, advising on experimental designs, data to be gathered, and sampling methods.

Training Programs (in-country, short-term)

Four 2-week training programs on crop production technology were conducted by subject matter specialists of DAE. Seventy subject matter specialists completed the training, taking up to 30.3 man-months as shown in activities table 6.4.3.

Another training program was to update the knowledge of field assistants and field men from OFRD of the cultural practices used in growing major crops and explaining FSR methodologies.

The other two training programs were to teach subject matter specialists and farmer cooperators how to establish wheat field demonstrations, and advise farmers on the cultural requirements for major crops.

A total of 60.6 man-months were used for all training programs.

The associate production agronomist's involvement in the training programs was:

- initiate the subject matter specialists' training on crop production technology

- prepare evaluation questionnaires

- overall supervision of training activities

- prepare and submit reports of the training programs to BARI headquarters and FAO authorities

- serve as resource person on some topics

Preparation of Regional Research Annual Reports and Survey Questionnaires

1. Three regional research annual reports were edited; two were published and distributed and the third submitted to the PSO to

negotiate printing. They included all research projects conducted in the research station for 1980-1981, 1983-1984, and 1984-1985, as well as data on rainfall and temperature and the lists of research officers. The associate production agronomist edited all articles for these annual reports.

Annual reports prepared, RARS, Jessore

Year of annual report	No. of articles	Total no. of pages
1980-1981	35	64
1983-1984	30	48
1984-1985	56	133*

*Typewritten pages before publication.

2. The associate production agronomist coordinated preparation of the 6-year CSR/FSR and MLT research reports, (1980-1981 to Kharif II, 1986-1987), including writing portions of them. These reports described methods used in experiments, data gathered (by replication where available and applicable), and presented a brief discussion of results.

3. Survey questionnaires prepared:

   - Farmers' practices on wheat relay crop on t.aman rice, Kushtia.

   - Groundnut production practices, Chuadanga.

   - Farmers evaluation of SS-75 performance in 6-MLT sites, Jessore.

   - Performance of impact points of the T and V extension program, Jessore.

   - Evaluation of the training programs for the four SMO training programs, and two FA/FM training programs.

4. Assisted in preparing the following questionnaires:

   - Homestead survey, FSR site, Jessore.

   - Benchmark survey of FSR sites in Barisal and Faridpur.

   - Date palm production and utilization.

5. Prepared a report on the agronomic aspect of cotton production in Bangladesh.

6. Prepared training syllabuses for mango production and for soil and fertilizer management.

7. Prepared a manuscript on "The innovative wheat relay cropping on t.aman rice." It describes the farmers' practices in the t.aus - t.aman - wheat (relay) cropping pattern, results of experiments on wheat relay crop in 1985-1986 and experiments being conducted in the 1986-1987 rabi season.

Conducting Field Days

Field days at FSR and MLT sites, and at Kushtia were organized by BARI scientists in cooperation with officers of the DAE. Farmers, cooperators, and neighboring farmers from various upazillas were invited to attend.

Field days in RARS/Jessore, were only conducted during the rabi season. At the FSR and MLT sites, field days also were held during kharif I and II seasons to show the performance of b.aus and t.aman rice which were part of the cropping pattern tests. The focus of field days in Kushtia was management practice trials on wheat relay crop into t.aman rice. Field days provided an opportunity to observe the performance of crops undergoing various tests in the RARS farm and in farmers' fields; they also allowed for an exchange of ideas between researchers, extension officers, and farmers.

During this reporting period, a total of 36 field days were held in the greater Jessore district. This constituted a total of 9[illegible].3 man-months, table 6.5.4(b). The associate production agronomist's participation in field days were to:

- assist with their organization
- initiate the preparation of materials for distribution to participants
- initiate the preparation of simple questionnaires to gather opinions from farmers and extension officers regarding the subject being shown
- provide guidance for collection of questionnaires and summarizing answers in order to prepare conclusions, and for use when planning future research

Technology Transfer

Some aspects of technology were used in various activities at 1) RTC/DTC workshops, 2) training programs, 3) field days, 4) research review workshops, and 5) conducting on-farm trials with farmer cooperators.

More farmers have started to grow BR II and Binasail in the kharif season, and Hashi Kalmi in aus, however, the extent of the increase was not evaluated. The quality of Tasaki Mula in the market also improved. Cropping intensity at the FSR sites went from 150 in 1980-1981 to 220 in 1986-1987.

Farmers are now applying zinc and sulfur to t.aman rice and increasing their use of insecticides.

4.3.5 Hathazari

An associate production agronomist was posted at RARS Hathazari, from June 1982 to June 1984. However, technical assistance continued throughout the project. Significant achievements were accomplished in systematic research planning for on-station and on-farm research. Residual effects of phosphorus and potash from upland crops (wheat, potato, cowpea, cabbage) to rice were investigated in on-station cropping pattern studies. These patterns are now in on-farm test throughout the country for final recommendations to farmers. Sulphur deficiency in various crops was identified. Gypsum, a by-product of TSP manufacturing, was applied as a sulphur source. This practice raised yields of various crops and was recommended to farmers. The use of gypsum on farms has substantially increased in the Chittagong area.

A research thrust for generation of new technology was given for the cowpea crop, a unique major winter crop of the Chittagong area. Research on potato including true potato seed; tomato, cabbage, and fodder crops were strengthened. The irrigated area of Chittagong is more than 40% but all land is not put to optimum use. To rectify this, a three crop cropping pattern was introduced.

Cropping systems research was conducted on farmers fields at Hathazari. Seven cropping patterns with associated technologies were tested and modified for 2 years. The rice-potato-maize cropping pattern was most profitable, labor use was uniform, and also provided fodder for cattle. Rice (t.aman) - mustard - rice (boro) was the most profitable pattern developed under irrigated conditions. These patterns were put under multilocation testing in recommendation domains.

In addition, cropping patterns of rice-rice and rice-rice-cowpea were recommended for multilocation testing under rainfed conditions in the Chittagong region.

The cropping pattern studies were so successful that the area around the Hathazari site is now under high yielding varieties of rice.

The first farmers' field day was organized in August 1982 at this station. Success was so high it was followed by a series of field days each year which helped in dissemination of technology and establishing linkages between the extension support service organizations, Chittagong University, research institutions, and private voluntary organizations. All together eight field days in 1982-1983 and 11 in 1983-1984 were organized where over 1,700 participants attended.

4.4 ECONOMICS AND SOCIAL SCIENCE

Several key areas should be highlighted such as interinstitutional linkages, human resource development, and development of methodology for handling socioeconomic data. There are discussed briefly in turn.

Interinstitutional Linkages

An important method used to encourage interinstitutional research linkages was through the contract research program. This involved review of research proposals followed by evaluation, monitoring, and a biannual review of all ongoing research. A large number of individual research institutes participated in the process. For example, during the 1985-1986 plan period six institutes completed research projects (see section 6 for a complete listing) and a further six were in process. In each case, the major topics fell under the broad categories of research suggested by the technical working group for the Agricultural Economics and Social Science (AESS) Division of BARC.

Institutional linkages have also been strengthened through a memorandum of understanding between BARC and both BARD and RDA, Bogra -- two institutes outside the agricultural research system per se. In addition, continued strengthening of linkages occurred through all other normal activities.

Human Resource Development

One of the objectives of the economic and social sciences specialist was to create a sustained capability in the research system. To this end, a series of short training courses were developed. Some 21 shortcourses were presented to 344 participants at 10 different locations involving participants from a wide selection of institutes and government ministries (see section 6 on in-country training).

One aim of these courses was to institutionalize one or more of the shortcourses. A descriptive statistics course was presented six times at GTI/BAU, four times at BARD, Comilla, as the core part of a somewhat longer course, and once at the RDA, Bogra. The course was being developed and taught by the BJRI and BAI. Other courses still need to be institutionalized.

Methodology for Socioeconomic Data Analysis

As a consequence of the program in human resource development, a number of follow-up activities were carried out to consolidate and encourage the application of these courses to research. These activities included:

- technical papers to serve as guidelines to field staff (19 papers were completed)

- workshop/seminars to encourage preparation and presentation of field data (9 workshops were held between October 1984 and January 1987)

- publication of a workshop paper series (23 papers were published between January 1985 and June 1987) (See table 6.7.4 for the complete list of publications and table 6.4.3 for workshops.)

Consolidation of training was also encouraged through the setting up of a BARC micro and main frame computer center. This center was in

operation for nearly 2 years before project closure and became a very active training center. It was also much used for supporting the national documentation center as well as for developing a number of national data files for use with international data systems (FAO, AIS) and the national planning process.

4.5 CROPS RESEARCH

4.5.1 Agronomy

The activities and achievements in agronomy were very broad and diverse in nature with emphasis on institutional development and transfer of technology. The agronomists assisted BARI and other institutes and organizations in organizing and implementing production-oriented, multidisciplinary, and multilocation research programs. They were primarily involved in research programs on important food crops, especially wheat, oilseeds, pulses, and root crops with a focus on upgrading agronomic research and manpower competency. Assistance was given to the improvement of research methodology, planning and review, and reporting and publication of research results.

Some of the agronomic studies, accomplishments, and recommendations are listed as follows:

- Evaluation of the Baromashi variety of blackgram for winter cultivation.

- Studies on nodulation and nitrogen fixation of different *Rhizobium* strains of blackgram (*Vigna mungo*) and khesari (*Lathyrus sativus*).

- Development of a maize demonstration program involving workers of different disciplines and institutions in an on-farm production program.

- Conducted band versus row placement fertilization trials.

- Developed course outline and details for a basic course in field experimental technique and statistical training.

- Presented various lectures on statistics, field plot technique, experimental designs, and plant-soil relationships.

- Assisted in putting equipment into operation.

- Evaluated the organization and productivity of the BARI Agronomy Division.

- Assisted in establishing priorities in agronomy research and in developing the national agronomic research plan for the next 5 years.

- Studies on application rate of sulfur and zinc were conducted on rice.

- Assistance was given in research proposal writing, field plot design and technique, and in the interpretation, summarization, and reporting (both orally and written) of research results.

- Assisted in organizing and presenting a short-term training course for farm managers.

- Assisted with the maize trials on 1) evaluating different varieties (composites) under various management practices and plant populations at several locations and 2) intercropping with blackgram, mungbean, and cowpea.

- Assisted in removing physical constraints to crop production. This was accomplished by subsoiling and providing effective drainage.

- Recommendations were made for restructuring of the Agronomy Division, BARI into sections to deal with 1) multiple cropping, 2) dryland management, 3) weed science, 4) salinity management, and 5) crop physiology.

  It was also recommended that soil fertility work be shifted to the Soil Science Division and that the following six areas receive emphasis: 1) rainfed agronomy, 2) irrigation management at the field level, 3) weed sciences, 4) seed physiology, 5) saline soils research, and 6) interdivisional linkages.

- Suggested 1) framework of several experiments for stabilization of yields in early kharif season, 2) modification of planting geometrics of maize and cotton to accommodate low-growing crops of grain legumes as intercrops, and 3) screening of low water requiring crops of oilseeds, pulses, and cereals in the dry post-monsoon season of the normally monocropped Barind tract of northwest Bangladesh.

- Assisted in preparing a project proposal for the establishment of a Center for Agricultural Research in Dry Areas (CARDA).

A few of the agronomic research results are highlighted:

- Early kharif rice yields doubled by growing alternate strips of rice (4 rows) and sesbania, the latter was turned into the soil when the sesbania was 45 days old.

- Maize intercropped with blackgram gave higher economic returns than a sole crop of early kharif broadcast or row-seeded rice.

- Use of early maturing rice permitted establishment and growing of a second crop, such as mustard, making use of residual soil moisture. Better stands and yields were obtained when both seed and fertilizer were drilled in the drylands of Barind (normally monocropped).

- Minimum tillage in rice stubble along with seed and fertilizer placement permitted successful establishment of post-season crops

(mustard, sunflower, safflower, niger, etc.) even in irrigated areas.

- Fungicide seed treatment of chickpea followed by drilling at 5 cm depth, in order to reach soil moisture, resulted in excellent stand establishment.

- The salinity level of surface soil of newly reclaimed land from the sea, in the coastal areas of Noakhali District, increases from E.C. 3.5 in October to 8 or 10 in March, making establishment of a crop after monsoon rice almost impossible. Use of straw mulching reduced upward movement of moisture and salt and permitted the growing of a wheat crop with fairly good yield.

4.5.2 Crop Science

Emphasis was given to improving the production potential through introduction, breeding, and agronomic research on maize, barley, millets, sorghum, a number of food legumes (pulses), and the oilseeds. A number of policy documents on these and other crops were prepared for BARC and USAID. Assistance was given to BARC in organizing and implementing nationally coordinated programs of research on these crops, including the establishment of close linkages between the crop improvement programs with farming systems research involving on-farm evaluation of new technologies and their rapid dissemination among farmers.

The activities and achievements of the specialists and consultants in crop science included the following:

- Survey made to estimate acreage and production of different root crops in various parts of the country.

- A good number of local and exotic cultivars and tuber crops were collected for multiplication and screening. This included cultivars of sweet potato, aroids, cassava, yam, and yam bean.

- Exotic and local germplasm of blackgram, mungbean, and khesari (*Lathyrus sativus*) was collected and evaluated.

- Breeding lines of blackgram and low-toxin khesari, originating from the "mutation breeding" and selection programs at BINA were subjected to adaptation studies across varying soil conditions.

- Assistance was provided to BARC in preparing and publishing "Strategy on Crop Diversification for Minor Crops in Bangladesh." This major policy document resulted in several priority projects. Similarly, USAID was assisted in a survey on the prospects of maize, millets, cotton, and oilseeds.

- Assistance was rendered to BARC in designing experiments to evaluate the advanced breeding trials in late kharif and rabi pulses. Crops included were chickpea, lentil, pigeon pea, mungbean, blackgram, and *Lathyrus* (khesari). A large number of advanced lines of pulses

selected earlier and new ones introduced from outside, were subjected to multilocation trials.

- Advised BARC and the Ministry of Agriculture on intensive rabi cultivation plans.

- Assisted in formulating and conducting an agroecological and socioeconomical survey on khesari cultivation in Bangladesh.

- Assisted in preparing and publishing 29 technical and policy documents (see list, section 6.7.5).

- Participated in and significantly contributed to many meetings at the Ministry of Agriculture. Some were concerned with policy matters related to research and development.

- Helped set up analytical laboratory at BARI for rapid determination of protein, oil, moisture, and basic amino acids. Assembled the infrared analyzer. Standardized the technique for toxin determination in Lathyrus, and helped BARI's wheat laboratory set up its quality estimation equipment.

- Assisted World Bank, ADB, CIDA, and USAID in project formulation, drafting of terms of reference, and monitoring and evaluation of projects on behalf of BARC.

- Assisted BARC in conducting detailed evaluation of 1) contract research projects and 2) manpower training needs.

- Conducted training of field workers and extension agents and delivered lectures on 1) crops research planning and experimental methodology, 2) research strategies for contingency planning, 3) oilseeds, 4) field plot techniques, and 5) hybridization techniques in various pulse species.

- Assisted in revitalizing the national pulses research network and strengthening the program.

- Assisted in field monitoring of crop research contracts and in the review of results and accomplishments of these.

- Assisted in the field in 1) planning of a large number of pulse and oilseed experiments and 2) designing of a seed store for pulse germplasm.

- Helped BARC in formulation of a long-term project on maize and groundnut improvement.

- Helped BARC in conducting various workshops, (maize, spices, tubers, pulses, and oilseeds).

- Helped BARC in evaluating research contract proposals in crop science.

- Helped the Sugarcane Research and Training Institute in formulating a long-range research and development policy on sugarcane improvement.

- Beginning in November 1985, the crops specialist became fully engaged with drafting the NARP (National Agricultural Research Plan) and in providing assistance to various institutes in the preparation of their master plans.

- Assisted in establishing a National Groundnut Improvement Program. Many experiments were conducted at widespread locations. Over 500 germplasm lines were introduced and evaluated.

- A short-term maize consultant was in Bangladesh for 3 months and made detailed and realistic recommendations for "Planning a Maize Research and Production Strategy for Bangladesh." His report deals with constraints to and reasons for maize production in Bangladesh, provides suggestions for popularizing and promoting maize, and details both a production plan and a maize research program.

- A local consultant was hired to look into the status of fodder crops and fodder potential of by-products of major crops. His report formed the basis of a detailed study on fodder by the livestock division.

- Five books and monographs in crop improvement and more than 40 reports and publications were published during the project period. Proceedings of several workshops (published and unpublished) layed the foundation for interdisciplinary, interinstitutional, and FSR-related crop improvement programs.

4.5.3 Horticulture

ARP-II activities in horticulture took place principally at BARI. Assistance and guidance given by the specialists focused on the GOB objective of achieving self-sufficiency and an export capability in horticultural crops.

Major activities centered around two general areas:

Training

The horticulture specialist position permitted daily availability for assistance in field evaluation of production and trial crops at BARI, outlying field stations, and farmers fields. Field training is essentially a nonmeasurable quantity but in reality is probably an equal or greater contribution than organized classroom studies. As representatives of developed countries, one of the most important contributions is the graphic demonstration of how our agricultural industry operates. What is written in books is available everywhere but the problem is bridging the gap between books and field application.

A continuing effort was made during the project to send students out of country for degree training. One Ph.D. and one M.S. student completed degrees under this program.

Extensive efforts were made for students to attend, on a regular basis, the yearly vegetable production training program held in the Asian Vegetable Research Development Center at Kasetsart University, Bangkok. Unfortunately, very few students were able to attend due to Bangladesh government travel restrictions. The new travel rulings should permit regular attendance in the future.

In-country training of horticulture extension workers was supported by the project. This included program development, venue selection, and implementation. Active participation was taken in the national yearly evaluation of research proposals and evaluation of completed yearly reports. The immediate impact of this sort of research/training assistance is elusive. An immediate change in the direction of research at BARI may not be seen. However, at least the significance and approach of some ongoing research was, and hopefully will continue to be, critically assessed.

Research Development

Vegetable production places an intensive demand on agricultural land. In comparison to field crops utilizing larger areas, the higher production potential together with much higher yields, capital inputs, and labor, involved in vegetable production; necessitate well-drained, highly productive land. It is generally accepted that the BARI farm is not suitable for horticultural research. Saturation of the soil after the last summer rain is such that nearly 60 days of drying weather are needed before first tillage is possible. On proper land this delay should not exceed 1 week. Accordingly, farm research plantings are delayed to the point that results are of questionable value. In addition, vegetable plants are field planted in small 8" holes filled with sand and manure. Thus, root systems of the plants are restricted to this area and mature plants attain only 1/2 to 1/3 the normal size of the same plant grown in proper soil. For both yield trials and variety development, this situation is not acceptable. Efforts to improve the major portion of this area was not possible due to lack of funds for soil amendments.

On a small portion of the horticulture farm developed by the Japanese Government (CVSRC), approximately 12 inches of sand was placed on the trial grounds and partially disked into the topsoil. Trials in this section accordingly are normal in growth.

Seed Production

Historically, the vegetable section has devoted considerable effort in developing seed production for the major winter season crops such as cabbage, cauliflower, broccoli, radish, carrots, etc. For various reasons there have been serious errors in part of the effort which reflects lack of training and experience on the part of the research worker involved.

Farmers are generally unwilling to purchase locally grown seed. They mostly depend on imported varieties. This situation is likely to persist until the underlying problems are understood. A starting point would be to send students for training specifically in seed production. In the 1986-1987 work plan provision was made for a scientific officer to review seed production in neighboring countries and possibly establish a contract seed production arrangement. This would provide an early solution to the problem. At the same time the department could explore production in the northern latitude of Bangladesh.

Biennial crops such as onions, carrots, radish, etc., technically cannot be grown for seed in a tropical climate. Seed of these crops should either be purchased directly or grown on contract.

Variety Development

Winter season vegetables are not in short supply. However, at the end of the monsoon there is a void which lasts until the earliest winter crops appear. Accordingly, early maturity is important and nets highest returns for the farmer. The earliest maturing cauliflower this year was a Winrock introduction from Michigan State University. Seed increase of this promising variety was made for extensive trials in the future.

The summer season is the least productive for vegetables. Few, if any of the western types survive. The most adaptable exotic types would theoretically arise in climates such as the southeastern United States. These would include the cowpeas, collard greens, etc. Both these crops have done well in this area; ethnic acceptance is a matter of question. A recipe in Bengali for collards was provided to the home garden program leader. Sweet corn can be planted continuously in Bangladesh. An open pollinated super sweet variety was introduced and is in seed production for distribution.

Home Garden Development Program

Early in 1986 USAID provided additional support for home garden development. Accordingly technical and material support was provided to the FSR project at Ishurdi. Funds for 40 hand tubewells, fencing, etc., were provided. The most affordable pump proved to be the rower pump designed by M.C.C. In mid-December, three wells were bored, and with technical assistance from M.C.C. were equipped with rower pumps. The well profiles and report are shown as appendix 1. Since the rower pump is new to this area it was necessary to determine its performance in comparison to the well-known No. 6 cast-iron hand pump. Currently it appears without question, that the rower pump will deliver a greater volume. The problem is that women and children involved in the home garden, do not have the strength to pull the rower pump piston during the low static water level between March and the monsoon. M.C.C. was informed of this development and perhaps an optional design or modification to increase leverage, may evolve to correct this problem. The limiting factor for success in home gardens depends on reliable water during the winter season.

4.6 LIVESTOCK RESEARCH

General

The most satisfying achievement of the livestock program was the significant change in research orientation of scientists and administrators from limited academic on-station livestock research, to the new systems concept of the Livestock Research Institute with interinstitutional agreements, including BAU and all the crop research institutes to conduct interdisciplinary on-farm research. While this cannot be listed solely as a livestock sector achievement, it perhaps required the greatest effort due to the modest point from which livestock research started. This important step was followed by training programs and development of working guidelines. More such encouragement will be needed in the future to help both scientists and administrators recognize the benefits and to give their support to the long-term effort still ahead for the institute.

Administrative Counseling

Frequent counseling with the member-director/BARC as well as additional working sessions with livestock officers of the division resulted in a favorable atmosphere to improve interactions with other institutes and disciplines. Through these interactions BARC and other institutes formulated agreements for working together as interdisciplinary teams in farming systems research. These ideas or concepts were not exchanged in one meeting nor even directly, but rather through many small actions to incorporate them into ongoing activities of the division.

Activities around which these interchanges were made are not reiterated because they are listed in detail in following sections of this report. However, some generalities about planning, budgeting, implementation, and follow-up on these activities will better define the nature of the exchange.

Efforts of the livestock component can be grouped as administrative counsel, research institute infrastructure planning, training, and commodity selection and procurement. The daily contacts or counseling with the member-director and(or) the division livestock officers were to assist with writing research priority recommendations, preparing livestock sector reports, preparing work plans, speeches and training programs, jointly attending meetings with producers and scientists, evaluating and revising research proposals, selecting degree candidates and new employees, serving on committees to write the livestock/FSR contract agreement and representing BARC in the preparation of the Livestock Research Institute Master Research Plan. This involved many meetings with research and extension scientists of BAU, LRI, DLS, FSR program coordinators of BARC, crop institutes and others interested in livestock production and its interaction with crop production. These meetings were held at various locations from BARC, to each of the other institute headquarters to regional research centers throughout the country to private farming/livestock enterprises, as well as with various donors.

In these meetings and site visits the member-director and officers were encouraged to promote interinstitutional cooperation and interdisciplinary research at the farm level. Much of the past 3 years was spent developing this interinstitution and interdisciplinary orientation within the BARC Livestock Division while encouraging other institutes to take advantage of the new interest among livestock scientists. Ultimately, it was the persistent requests and demands of the crop institutes for assignment of livestock officers to each institute through LRI and the BARC/FSR program that such an agreement was formulated.

Infrastructure Planning

The BARC Livestock Division, in close coordination with LRI, drew up an agreement for LRI to hire livestock scientific officers and assign them to crop institutes to support the livestock research and extension component of FSR sites. LRI also agreed to furnish training and on-the-job supervision from a core livestock systems research division staff working out of LRI headquarters. LRI finally received GOB approval to hire the field and headquarters scientists after many months of negotiations and delays. They were hired in early April 1987 in order to participate in the general FSR training program being conducted by BARI in late April.

The livestock specialist and the BARC Livestock Division worked very closely with the World Bank/FAO Expert Planning Team in planning of the Livestock Research Institute Master Plan which not only defines a research infrastructure within LRI, but a complete interlinking infrastructure of all institutes involved in livestock research and extension. The master plan is explicit in its design to include livestock as an integral part of agricultural system with interdependence between livestock and crops. While major emphasis is on the small farmers' system, the livestock systems research is flexible enough to include commercial poultry and dairying in areas where market demands and resource availability present an economic opportunity for farmers.

Special support for research projects outside the normal research infrastructure was considered for 16 proposals, of which seven were approved for financing. While monitoring and evaluation of past contract research was disappointing, the recent monitoring activities of the new member-director and his staff was encouraging.

Training

In-country training programs were planned and designed, consultants located and hired, financed, implemented and conducted, for and with the help of LRI, DLS, BAU, and the crop institutes. Topics included research methodology, cattle and buffalo production, animal feeding and breeding, feed and fodder production and utilization, commercial poultry production management and feeding, homestead poultry production, extension methods, biogas production, library science, and animal health. In preparation for more intensive training, (planned to be conducted with the help of an expatriate livestock systems research

training consultant but never taking place) several short on-the-job training trips were made to FSR sites where the livestock specialist and BARC livestock officers demonstrated livestock handling and data collection methods. Improved technologies such as urea-treatment of rice straw and vaccination programs were discussed and farmer/technician training programs were organized at the regional station level through cooperation of BAU animal science staff.

Six M.Sc. and four Ph.D. candidates were supported at BAU. Periodic meetings were held with the vice-chancellor, the deans of animal science, veterinary medicine, agronomy and agricultural economics faculties, heads of departments and professors to discuss curriculum and interfaculty and interdepartmental degree and research programs. Considerable interest was expressed in interdisciplinary education and research programs, but old standards seem hard to change in practice.

Overseas training was primarily to the benefit of BAU since the vice-chancellor was able to approve up to 3 months overseas training for his staff while other institutes, including BARC, were required to obtain GOB clearance which effectively eliminated most candidates offered. Fortunately for future training programs, the BARC EVC has now been granted authority to approve such short-term training. The livestock member-director was very verbal in expressing his support to obtain the GOB ruling to give the EVC this authority.

Nonetheless, BARC was able to send scientists away for short-term training in zoonotic diseases, poultry production, animal fertility, nutrition, and microbiology. Two students were also sent to the Philippines on Ph.D. degree programs.

Much effort on the part of both BARC and LRI scientists was expended in preparation of several papers in cooperation with the livestock specialist for presentation at local and international conferences. Local scientists participated in presentations at local conferences, while the livestock specialist represented Bangladesh at three international conferences due to lack of GOB clearance for his counterparts.

Commodity Selection and Procurement

Commodities were purchased for both LRI and BAU to supplement existing laboratories, equip new laboratories in animal nutrition and health, to equip field data collection teams and to stock the LRI library with books and journals. While this meager start to build an animal research library was small, it encouraged young animal scientists to review those books and journals received to date. And, they regularly asked for more, and were searching for the most recent information in animal systems research, as well as other more conventional fields.

Only the minimum laboratory and field research equipment was obtained for LRI, however, with the cooperation of BAU and DLS laboratory facilities; most research projects can be accommodated until expansion can be justified at LRI.

4.7 SOIL MANAGEMENT

The objective of the soil management component of ARP-II was to improve the national capability in all aspects of soil management. Three broad areas were selected. They are listed in order of priority.

- Development and management of a national soil fertility evaluation and improvement program.

- Improvement of other soil management areas including soil microbiology, soil physics, soil salinity, tillage practices and soil and water conservation and management.

- To integrate the above into the overall ARP-II farming systems program by offering analytical services, research information, and cooperative research.

Major achievements towards the objective were made in all areas. These were obtained by a concerted effort on the part of national scientists and administrators, and expatriate specialists and consultants. These are reviewed briefly below.

The soil fertility evaluation and improvement (SFEI) program had six components: 1) sampling and sample handling, 2) laboratory development and maintenance, 3) data interpretation, 4) research, 5) recommendation preparation, and 6) outreach.

Initial Achievements

A national SFEI program in Bangladesh could not be successful unless it received support from several government agencies and donors. For this reason in 1983, BARC published a bulletin titled "Soil Fertility in Bangladesh," which provided guidelines for program development. At the same time, donor's resources, principally from USAID, CIDA, and IDA were channeled for appropriate expenditures.

The physical facilities designated by BARI for the model laboratory were inadequate. The entire area was renovated and appropriate facilities and utilities installed in order to utilize the multiple unit system ordered.

A greenhouse facility is essential for soil fertility research. None was available at BARI. Financing was obtained from CIDA and one constructed in late 1983.

In order to advance laboratory, greenhouse and field research, soil samples were collected from agriculturally important soil series and sent to the United States for analyses and "sorption" studies. Greenhouse trials were initiated using these results.

Four PSO level scientists from different institutes were sent abroad for 3 months of short-term training in SFEI program concepts. They formed the core program leaders.

Component Achievements

Sampling and sample handling. A brochure in Bangla was produced and distributed to extension and other personnel which described how to take a correct soil sample.

A sampling study research component was included in the ongoing Soil Test Crop Response Correlation Contract Research Project. Data from this should contribute significantly to adjusting international sampling standards to Bangladesh conditions.

An information sheet was developed in Bangla that is sent in with each soil sample. This is used for preparing the recommendation and will be used in developing a national soil fertility summary.

Laboratory development and maintenance. One high capacity central laboratory was established at BARI, Joydebpur. This facility offers a fast (3-week turn around) and accurate analytical service to researchers and farmers. The utilization of this facility was increasing. In 1983 only about 2,000 samples were analyzed with five determinations each. In 1986 about 7,000 samples were analyzed with 12 determinations each. This not only improved a valuable service to researchers and farmers, but also expanded the information base on the fertility status of Bangladesh soils.

Laboratory facilities at other institutes were also improved and procedural standardizations amongst laboratories was taking place.

The soils program cooperated closely with the ARP-II laboratory maintenance program; first by coordinating consultancies and later with training. The soils laboratories at all institutes benefited by this cooperation.

Data interpretation. Data from research and laboratory analysis undergo constant study both for their biological and economical interpretation. It was only recent that a sufficient number of trials were completed to do good data interpretation. In general, correlation of the "imported" analytical methods with crop response was good under Bangladesh conditions. Modifications for some elements, principally K, were made.

Research. Research took place on three fronts: 1) laboratory, 2) greenhouse, and 3) field. Significant findings were reported in various BARC and international publications. These included information on all 13 essential plant nutrients found in the soil. Priority work, of course, focused on N, P, K, S, and Zn which proved to be the most widely spread plant nutrient problems in Bangladesh.

It was generally recognized that during the period of ARP-II, the quality of soil fertility research improved through a more systematic approach. BARC contract research was very instrumental in this transformation.

Recommendation preparation. In 1985, a 79-page "Fertilizer Recommendation Guide for Most Bangladesh Crops" was published and

distributed. It was the first such guide in Bangladesh that recognized 1) the need for different yield goal targets and 2) the importance of the soil fertility status of the field to be fertilized. The guide included information on time and methods of application as well as the quantities of each nutrient to apply.

It was recognized when it was published that revision of this guide would be essential as new research information became available. A revision should take place before the end of 1987. It was expected that the new (1988) guide will be published in Bangla. This in turn will need revision in another couple of years.

Outreach. Besides the publication of policy position papers and research documents mentioned earlier, the ARP-II project was instrumental in training scientists, extensionists, fertilizer dealers, and farmers. It is estimated that the soils management program through their own courses or in cooperation with other programs/organizations taught over 300 persons annually during the 5 years of this program.

To bring prestige and a high level of technical competence and expertise to the soils management program; four international symposiums were sponsored by BARC. These included 1) Soil Test Crop Response Correlation Studies, Commission IV, ISSS, 2) Potassium in Agricultural Soils, 3) Minimum Tillage, and 4) Sulphur in Agricultural Soils. Proceedings of all four were published and circulated worldwide.

Achievements in Other Program Areas

The initial priority of the soil management program was focused on soil fertility. However, it was recognized that other soil factors needed attention. A brief description of the achievements to date in each of these is presented.

1. Soil Microbiology

   - Several consultancies were initiated and reports were written (Beck, Davis, Gross, Chowdhury, Boonkerd)

   - Commodities procured for various institutes

   - Two contract research proposals were developed (one completed, one ongoing)

   - Extension training courses were institutionalized through four shortcourses held over the last 4 years and publication of a training manual

2. Soil Physics

   - A consultancy by Dr. S. S. Prihar taught individuals through advisory sessions and developed a procedures manual for soil physics

   - Commodities procured for various institutes

- A contract research proposal was developed for studies on land use planning using soil physical measurements

3. Soil Salinity

   - A consultancy by Dr. G. R. Sandhu through the water management program area, assisted in the development of a soil salinity contract research project

   - Commodities procured for various institutes

   - Two contract research proposals were developed (one completed through water management, and one ongoing in soils)

4. Tillage Practices

   - Three consultancies accomplished (Blevins [2] and Murdock [1]) with reports prepared

   - Ideas from above consultancies introduced into ongoing contract research project

   - Farming systems research being conducted on tillage practices

   - An international symposium on minimum tillage was held

5. Soil and Water Conservation and Management

   - A consultancy by Dr. James Box was completed and his report submitted

   - Recommendations from Box consultancy to be incorporated into contract research project being initiated

Other Achievements

One of the objectives of the soil management program was to integrate its efforts and findings with those from the overall farming systems project objectives outlined in ARP-II. This was done in the following ways once a sufficient database was established:

- Analytical services offered for soil, water, and plant analyses for all projects from all institutes.

- Research information was disseminated to on-farm researchers, extension, and others. About 50% of it is being tested on-farm.

- Contract research became better focused and more integrated among participating institutes. Assignment of tasks was more frequently being based on capabilities and expertise in individual institutes.

- About 80% of a total of 90 recommendations made by consultants to the soil management program were incorporated or initiated. About 10% of the recommendations were not feasible or applicable while

most of the remainder were out of the area of influence of the soil management program.

A project such as ARP-II has a definite period. When it ends contacts with international scientists must not. It is necessary to have these contacts for the program to receive technical inputs and continue to grow. An attempt was made to achieve these sorts of contacts. A list and description of activities is given below:

- International Fertilizer Development Center: local dealer training, consultancy visits, funding of cooperative research in N efficiency

- Potash and Phosphate Institute: consultancy visits, assistance with local and overseas training, providing training materials, and funding contract research

- Canadian International Development Agency: funding for commodity purchases, construction of BARI greenhouse, consultancy visits, and contract research funding

- Kasetsart University: x-ray diffraction analytical services and training in Thailand

- Other International Research Centers: training during short-term observation tours or courses, providing technical material and consultancy visits

- International Potash Institute: consultancy visits, financing for attending international meetings, and providing technical books and training material

- Agro Services International: consultancy visits, providing analytical methodology, analytical quality control, and local and U.S. short-term training

- University of Hawaii, NifTAL Project: consultancy visits, microbiological materials for local testing, short-term local and U.S. training, and network information exchange.

- Biological Nitrogen Fixation Resource Center (NifTAL/Thailand): consultancy visits, microbiological materials for local testing, short-term training local and in Thailand

- University of Kentucky: consultancy visits, exchange of technical information, short-term training in United States

- Australian Centre for International Agricultural Research: (recently initiated) exchange of technical information and possible short- and long-term training in Australia

- The Sulphur Institute: providing partial financing for symposium and preparation of brochure, providing technical information for training and providing fertilizer materials for field testing

General Observations

The soil management program of ARP-II was successful in reaching its initial objectives. All participating institutes benefited from ARP-II. The Soils and Irrigation Division of BARC was strengthened technically, organizationally, and financially.

4.8 IRRIGATION AND WATER MANAGEMENT

The program's achievements are categorized into 10 broad but interrelated issues pertaining to irrigation and water management in Bangladesh. Specific activities carried out by the program are presented in section 6 in the respective tables, while major achievements under each of the categories follow.

Groundwater. The importance that groundwater plays towards irrigation development in Bangladesh cannot be overemphasized. The program was heavily involved in this activity; it played a catalyzing role in bringing together responsible agencies to deal with groundwater-related issues in the country, in a coordinated manner. The program vigorously promoted and technically assisted in the preparation of four contract research projects, now underway with IDA funds, dealing with groundwater resource assessment for planning and development purposes. These projects are strategically located to cover the widest possible spectrum of groundwater conditions, as they exist, in the country. A 4-week "Groundwater Investigation" course was institutionalized at BRRI, after it was taught for 3 consecutive years, benefiting nearly 50 engineers of various disciplines from research and development institutions. The course was wide ranging, covering both theory and practice, and constituted an excellent effort under in-country training activities. The responsibility for the course began under foreign instructors, was gradually shifted to a local team now fully prepared to continue the exercise.

Other relevant groundwater issues were assessed using both local and expatriate consultants, among these were:

- groundwater artificial recharge
- groundwater quality
- evaluation of water well technology
- conjunctive use of surface and groundwater
- development of criteria to determine optimal mix of shallow and deep tubewells

These consultancies generated very specific activities now at different levels of implementation and henceforth, will have an impact on water management practices throughout the country. Some of these are: a simple model for groundwater management; criteria for calculation of critical infiltration rate for use in groundwater recharge assessment; guidelines for the siting of tubewells; zoning of shallow tubewells (STWs) and deep tubewells (DTWs), etc. The program assisted both research and educational institutes in groundwater investigation; BRRI, BARI, BINA, BAU, and BUET benefited from this effort.

Finally, it should be pointed out that given the interdependence of the groundwater issue vis-a-vis other broad areas of the program, many other activities pursued also dealt indirectly with groundwater work.

Water lifting devices. This issue is intimately associated with groundwater. The program tackled this broad area from two perspectives: power and manual driven equipment. These will be discussed separately.

To assess the conditions of power pumps and motors in the country a two-tier contract research project was developed, i.e., "National Survey on Performance of Different Types of Tubewell and Low-lift Pump Equipment." The first portion of the activity -- a desk study was completed. The results provided guidelines to allow identification of the weak and strong points of particular types of equipment, leading to researchable items to be explored in the field performance evaluation component, the second portion of the study.

Other contract research projects developed under the program, most notably the "Integrated Irrigation Command Area Development" and "Response of Shallow Tubewells Going Dry Due to Declining Groundwater Tables," addressed the role of irrigation pumps in Bangladesh. Concrete results emanating from these projects included: better guidelines for siting of wells/pumps, identification of constraints towards increasing irrigated command areas, the need for standardization of equipment at the national level, and an improvement in "matching" the well-pump-motor complex. The course "Pump Irrigation in Bangladesh" now well established at the Graduate Training Institute at Mymensingh was developed and tailored to Bangladesh conditions through the program's efforts. It has now been taught entirely by local scientists twice a year for the past 3 years with a favorable response from the participants. Options in powering irrigation equipment were assessed through a consultancy that provided an in-depth analysis of the pros and cons of electricity, diesel, and LPG; with specific recommendations delivered to appropriate institutions.

In the field of manual pumps -- which included the so-called indigenous devices -- the program was again quite active through both contract funded research and organized training activities. The contract research study on the "Efficiency of Bamboo Tubewells for Small Scale Irrigation" evaluated different types of manual pumps and provided guidelines for particular environmental and technical conditions under which each pump would be more efficient. Another project, eventually funded by IDA but generated under the program, is ongoing with the objective of promoting and evaluating, both technically and agronomically, the different types of pumps in farmers' fields.

Under training, a course on "Manual and Animal Powered Pumps for Irrigation" was sponsored by the program. In addition to the benefits derived by 15 participants, this exercise pooled the various government and NGOs to jointly deal with the issues involved. Finally, the subject matter pertaining to manual pumps was included in other courses taught under different program sections, for example, in the course on "Irrigation and Water Management" for the directorate of agricultural extension personnel.

Water distribution system. One of the major reasons cited for the poor performance of minor irrigation systems in Bangladesh, was insufficient attention given to the design, construction, and provision of the distribution network and appurtenant structures. Various alternatives and strategies for improving the distribution subsystem for minor irrigation systems were discussed in a workshop attended by participants involved in irrigation development and management in Bangladesh. The "Improved Distribution System for Minor Irrigation in Bangladesh" workshop was followed by an international seminar on "Methodologies to Evaluate the Performance of Irrigation Systems." During the seminar guidelines were drawn up for carrying out the evaluation, how and when it should be done, and to whom it should be addressed. A local consultant was then retained to frame suitable criteria to measure and evaluate the performance of irrigation systems in Bangladesh.

Subsequently, three short-term consultancies jointly and severally presented very specific guidelines for providing low-cost measuring devices, control structures, and various conveyance loss reduction options, which included compacted earthern channels, lining canals with different materials, and an underground pipeline distribution system. One expatriate consultant specifically addressed and explored the potential of ponds ("Pukur") in an irrigation cum fish production scheme, and for buffer storage of night pumping for release during the daytime. This consultancy provided substantial refinements for the contract research project on the "Role of Ponds in the Irrigation Development in Bangladesh."

The above consultancies also facilitated direct consultations on specific problems during group discussions in formal seminars. Models were also built in the laboratory and workshops as well as in the field. Several permanent and portable measuring and control devices were built at BARI headquarters and its regional stations, and on the BRRI farms.

A contract research project entitled "Integrated Irrigation Command Area Development" implemented by a multidisciplinary team from BARI and BAU actually diagnosed field problems and constraints. They started the task of transferring available technology for improving water distribution systems and schemes to pump irrigators in Joydebpur, Jamalpur, Hathazari, and Mymensingh. Assistance was provided in testing the quality of locally manufactured pipes at BARI. Results were published in the Bangladesh Journal of Scientific Research and were very useful in establishing the first underground pipeline distribution system built from low-cost unreinforced concrete pipes in the Development Service Center Farm at Savar. Several other schemes were built thereafter by the Tangail Agricultural Development Project sponsored by the German government, and at Bogra under leadership of the FAO/UNDP-RDA team.

Irrigation of crops other than rice. The workshop on "Low Water Use Cropping Systems," jointly sponsored by the Crops and Agricultural Engineering/Irrigation Division of BARC, uncovered the sad fact that technologies for irrigating crops other than rice in Bangladesh, are extremely limited. When self-sufficiency in rice is attained, improvement in diet and nutrition will then become a priority, and the

demand for improved techniques in irrigating diversified crops will increase. The various activities completed were all supportive of the farming system concepts initiated by the crops division.

Three consultancies provided valuable suggestions and recommendations:

- appropriate irrigation methods for upland crops at research stations and on-farm research sites

- the potential of drip and sprinkler irrigation for export cash crops such as fruit and tea

- the practical and microcomputer assisted design for irrigation scheduling (a paper describing "Practical Approach for Irrigated Scheduling" was accepted for publication in the International Journal for Tropical Agriculture, India)

- prediction of crop water requirements

- development of operational procedures minimizing water loss

In addition studies by a local consultant on fodder crop production was supported. Assistance was also provided in the design of sprinkler irrigation (and drip irrigation as an alternative) for the production of mango seedlings at the BARI headquarters and at the Chapai Nawabganj Mango Seedling Production Station as a contribution to the Barind Tract Integrated Agricultural Development Project.

Two training programs were funded:

- In the course, "Manual and Animal Powered Pumps," one of the papers presented by the specialist introduced a modified "surge" flow irrigation technique. For low discharging manual pumps this approach can improve the efficiency in irrigating small patches with diversified crops.

- The course presented by Utah State University staff on "Water Production Functions" included subjects such as the response of diversified crops to irrigation, irrigation and fertilizer interactions, and the practice of deficit irrigation in regions with scarce water supplies.

An on-the-field layout for research and demonstration, using surface irrigation methods (furrow and border) for tomato, and field evaluation of sprinkler irrigation systems were carried out at BARI.

Under the Crops Division two out of six proposed contract research projects were funded to completion.

- Research covering the cropping systems at Jamalpur identified the most promising cropping patterns (and associated input requirements) for different classes of land in the district.

- At Jessore the feasibility and appropriateness of a low cost bamboo tubewell used in conjunction with simple pump heads for irrigating rabi crops and as a source of drinking water were demonstrated. Follow-up research to include several other manual pumps and to extend coverage of the study was implemented.

Contract research under the Soils Division quantified the response of wheat, potato, mustard, maize, cabbage, cauliflower, and tomato to specific quantities of supplied irrigation water at several RARS of BARI. The desirability of minimum tillage to conserve moisture and to reduce farmer's cost of production were also explored.

All generated technologies from these investigations were disseminated to extension agents in the regular extension and research district staff meetings. The same information was also used extensively by Bangladesh personnel in producing a manual for managing irrigated rice and diversified crop production.

Irrigation of problem soils. This issue is of significant importance to the program because of the potential impact on irrigation and water management activities throughout the country, particularly in the coastal areas. Close cooperation with the soils program was a key strategy in addressing this topic. The IWM program supported, both technically and financially, contract research projects that dealt with problem soils such as: "Coordinated Micro-nutrient Research under Irrigated and Nonirrigated Conditions"; "Management of Problem Soils under Irrigated and Nonirrigated Conditions"; and "Saline Water Irrigation and Crop Production in the Coastal Zones of Bangladesh." Results obtained were helpful in identifying specific soil problems in particular areas of the country; in testing alternatives to "Boro" rice production in the coastal belt; and establishing several cropping patterns tailored to problem soil areas, with varying degrees of success.

An expatriate consultant, in close cooperation with local counterparts, assessed saline soils vis-a-vis irrigated agriculture. This assistance to both the water and soils program areas sharpened the research focus of future research work, now ongoing as recent contract research projects undertaken by the soils program. An assessment of groundwater quality and the interrelationship with chemical pollution leading to potential soil problems was also pursued.

Overseas and in-country training was provided under this issue, with four scientists benefiting from soils and water management related courses both abroad (dealing with salinity aspects), and locally (where problem soils were dealt with in water management courses and workshops sponsored by the program).

Water management practices in terms of timing and delivery of the right quantity of irrigation water for salt affected areas, were implemented at the research level and were ready for testing in farmers' fields.

Sociological and economic issues in irrigation. Recognizing the valuable contributions of sociologists and economists in water

management, supportive activities were jointly implemented with the Agricultural Economics and Social Sciences Division of BARC. Four expatriate short-term consultancies tackled various issues such as the socioeconomic based identification of alternative options for powering irrigation equipment, the economics of DTW irrigation, the impact of irrigation on distribution of benefits, and development of criteria to determine optimal mix of STWs and DTWs. A local consultant was supported to follow up the preceeding activities.

From the recommendations of these consultancies, several research proposals evolved. The largest number of contract research projects, a total of nine funded under ARP-II, covered the following areas:

- socioeconomics of cropping system research in BWDB projects
- land use survey in irrigation projects
- technical and economic viability of DTW
- technical and economic viability of STW
- economics of supplementary irrigation
- response to STWs running dry
- chronological changes in irrigation systems in Comilla
- socioeconomic study of farming systems in irrigated and nonirrigated areas
- distribution of benefits from irrigation

This research

- identified reasons for low performance of DTW in Joydebpur, Feni, and Chittagong
- documented the technical and economical aspects of these same systems
- developed the best cropping pattern, fertilizer formulation, and tillage practices for Thakurgaon
- identified land use and associated socioeconomic changes resulting from introduction of irrigation
- documented the additional benefits accruing to supplemental irrigation of rice grown during the "Aus" and "Aman" seasons
- developed specific recommendations for handling tubewells that gradually dry up

All this research contributed significantly to the preparation of manuals used for in-country training programs.

Research and extension linkage. Transferable technologies generated from research stations required verification at on-farm research sites before being recommended to farmers. Multidisciplinary teams from participating research institutes, working with agencies responsible for irrigation development and management such as BADC, BWDB, BRDB, and DAE were trained to a diagnostic analysis. They were provided with instructions, given demonstrations, and were personally involved in documenting the operation of irrigation systems. Problems and constraints were identified, solutions, configurations, and alternatives generated, and implementation procedures and strategies for the recommended best solutions were presented.

Research results and the diagnostic exercise together were useful in completion of training manuals of the irrigation management program. These manuals are now available for ongoing IMP training programs at RDA-Bogra and various training courses offered by BARC to subject matter officers and subject matter specialists. These are the future water managers of the DAE on-farm water management component with emphasis on irrigation agronomy. Several papers were prepared and presented by the staff and specialists during these courses: evaluating irrigation system performances; irrigation extension procedures and practices; monitoring an irrigation crop calendar as a system management tool for extension agents; system operation planning and plan implementation following the IMP way; drainage requirements of rice fields; and research and training components in irrigation extension. On several occasions the specialists made field visits and gave advice on implementing improvements to water distribution systems at RDA, Bogra; Development Service Center, Savar; and elsewhere.

Development of personnel and institutions. Professional development of research staff and strengthening the participating research institutes' library, laboratory, workshop, and field research facilities were extensively promoted.

Human resource development was pursued through:

- training programs on remote sensing and applications in research for administrators and researchers

- short orientation courses on "Systems Approach to Planning and Managing Water Resource" at BAU and BUET, benefiting both researchers, and development planners and systems managers

- regional training course on "Water Management in Rice Production" sponsored by BARC in association with IDRC (Canada) and BRRI

- funding support for four local consultants who prepared the "Annotated Bibliography on Irrigation Water Management

- computerization of the "Annotated Bibliography" to allow easy access for researchers preparing contract research proposals, and to those writing reports of completed research projects

- hands-on training for selected staff of BARI, BRRI, BAU, and RDA, in computer-aided design and evaluation of irrigation systems, as well as research data management

- various on-the-job training programs for BARI field personnel involved in the Integrated Irrigation Command Area Development Project; this activity covered general topics on irrigation water management, training of trainers, and development of training programs for farmers during system operations planning and management

- personalized one-to-one assistance on writing research reports for BARI and BRRI agricultural engineers

- support for overseas training leading to Ph.D. and M.Sc. degrees, participation in various short-term overseas training opportunities, and attendance at international workshops and conferences

- a number of in-country training programs executed by expatriates alone, also collaboration between expatriates and Bangladeshi counterparts, and by local experts in Bangladesh

Institutional development was pursued through:

- close to US$300,000 worth of commodities to strengthen BARC and the primary participating research institutions such as BRRI, BARI, BUET, and BINA were ordered and installed

- plans to strengthen the irrigation water management program at BAU were prepared by a team of curriculum development experts from Cornell University and Colorado State University

- pipe (for underground water distribution systems) testing apparatus was developed at BARI

- a calibration facility for locally fabricated measuring devices was established at BRRI and shared with researchers at BARI

- prototype slit orifice meters and Froude scaled versions for pump discharge measurements were fabricated, tested, and calibrated at BARI (a paper describing the work was published in ADAB News and a master's thesis written and presented to the Asian Institute of Technology by the Bangladeshi counterpart involved)

- several portable long throated flumes, using locally available materials and equipment were constructed at the BRRI workshop

- portable in-field hydraulic conductivity testing apparatus, for surface and subsurface drainage investigation and evaluation studies were fabricated and used at BARI and regional stations in the coastal areas where drainage related problems exist

- a subsurface drainage system test and evaluation structure was installed and initial results obtained at BARI

Monitoring and evaluation of research projects. This activity was essentially the backbone of the program. An initial step leading to the program's involvement in this broad issue was the identification, and subsequent prioritization of researchable and relevant irrigation and water management aspects unique to Bangladesh. A two-prong strategy was followed: first, both local and expatriate consultants were engaged to assist in the identification process. As a result consultancies on "Irrigation and Water Management"; "Water Management Component of ARP-II"; "Water Management Extension Specialists Activities"; "Agricultural Engineer Activities"; and "Water Management Issues in Bangladesh" provided initial guidelines and recommendations on the subject.

Second, the program with assistance of an expatriate consultant, assessed the usefulness of holding a water management workshop. In October 1983, the workshop was held. More than 100 people participated representing government and nongovernment organizations as well as private institutions engaged in water management activities.

Monitoring and evaluation covered three distinct types of research projects:

1. contract research generated and funded under ARP-II

2. contract research generated under ARP-II but eventually funded through other sources

3. research which may or may not have been generated under ARP-II but was proposed and conducted by the research institutes through "core" funding

In each of these categories, program staff were actively involved in several or all stages leading to research project implementation, i.e., problem identification, proposal development, proposal technical review, and final proposal approval/concurrence.

Under category 1 the program dealt with 17 projects cutting across several BARC divisions, namely; soils and irrigation (4), agricultural engineering (2), crops (2), and economics and social sciences (9). As mentioned above the program's involvement in these projects started at the planning stage. After approval of funding, program personnel made regular visits to monitor progress, provide technical assistance, evaluate performances and assess impacts. Achievements of individual projects will not be dealt with here as they are highlighted under the pertinent issues/sections of the program. A list of these projects with duration information is presented in table 6.6.8.

Under category 2 the program dealt with over 30 projects. The precise number is elusive because many never went beyond the planning stage. As already pointed out the projects also cut across several divisions, in particular agricultural engineering, and soils and irrigation. It is worth mentioning that at least ten of these projects are ongoing with IDA funds, most notably the four groundwater and two pump issues already mentioned elsewhere. Efforts of the program in this category were concentrated mostly on planning and funding stages, although limited

monitoring and evaluation activities were also pursued on an ad hoc basis.

Under category 3 activities were directed towards the agricultural engineering departments of BARI and BRRI and on a lesser scale with BINA, SRTI, and SRDI. These research projects were used as spring boards to train IWM personnel and provide the institutes with equipment.

Finally, the program reinforced the monitoring and evaluation of research by means of alternating internal and external evaluations of the IWM program as a whole but with contract research receiving special attention. This was done by evaluating teams composed of local and expatriate scientists. Internal evaluations were held in 1983 and 1985 and external in 1984 and 1986. These have been fully documented.

Policy issues. The role of the program vis-a-vis policy issues pertaining to irrigation and water management promotion and(or) development in Bangladesh, needs to be brought into proper perspective and careful interpretation. The program had no intention of dictating or creating policy; a function for which the program was highly unprepared, but rather to bring to the attention of policymakers those issues identified through program activities, which could seriously constrain the efficient use of water resources in Bangladesh.

An important topic the program tackled through a consultancy in its very early stages, was related to legal aspects of water use in Bangladesh. A by-product of this effort was a "Water Law Bibliography for Bangladesh." This exercise had full support from both the Ministry of Agriculture and USAID, and eventually led to the development and adoption of a groundwater management ordinance. Likewise, it led to an international workshop on water law under the auspices of several ministries.

The program also engaged a multidisciplinary team of consultants to assess the organization and irrigation policy in Bangladesh by suggesting a framework for an integrated irrigation policy for the country. The consultants recommended that a study regarding the role of government policy concerning various water management choices, be pursued. This was translated into a research project that monitored the distribution of benefits from irrigation, under different ownership/management arrangements prevailing in the country as a consequence of recent irrigation related government policies.

Another mechanism the program used to address policy matters was through the technical evaluation of numerous documents submitted to BARC for their evaluation and comments. Among the many documents reviewed, those from the Master Plan Organization pursuant to the National Water Plan Project were noteworthy, since the implications on water management policy are obvious. In addition, those originating from the National Standardization Committee for Agricultural Machinery and the different ministries involved in water management activities received special consideration.

The impact the program achieved in this broad issue is difficult to quantify. However, the staff felt the involvement as pursued was justifiable given the far reaching role that irrigation and water management aspects play in Bangladesh.

4.9 PEST MANAGEMENT RESEARCH

Activity in the pest management program area in keeping with the ARP-II project plan, was delayed until late 1984 and early 1985. Program activities were poorly defined in the plan and did not reflect an understanding of problems and priorities for achieving realistic goals. Soon after arrival of the entomology and plant pathology specialists, a program was developed to enhance research within an integrated pest management framework.

Crop protection research had not maintained parity with associated sciences in the agricultural modernization process. Pest control technology, based largely on application of pesticides or exotic sources of host plant resistance, were assumed to be readily transferable from one geographic area to another without consideration of the often subtle differences imposed by ecological and socioeconomic conditions of the recipient. This approach is now recognized as inadequate to support economically and socially viable crop protection programs throughout the world. Emphasis is shifting to the more rational approach of integrated pest management (IPM): a systems approach to reduce pest damage to tolerable levels through a variety of techniques, including natural predators and parasites, genetically resistant hosts, environmental modifications and, when necessary and appropriate, chemical pesticides...relying first upon biological defenses before chemically altering the environment. The development of appropriate pest control technology through 1) development of research programs in participating institutes, 2) staff training and development, and 3) provision of necessary equipment and facilities were identified as broad objectives for the pest management program area.

1. Research programs in the Entomology and Plant Pathology Divisions at BARI were organized into crop and pest oriented projects in concert with the coordinated approach to crop improvement research adopted by the institute. Individual scientists were assigned responsibility for specific projects for long-term planning and research.

   Proposals were also accepted for coordinated research trials at the BARI headquarters and the RARSs in order to speed up the process of technology evaluation and adaptability to different regions in Bangladesh.

   Emphasis was shifted from a simplistic single focus approach to control to one based on principles of integrated pest management; identification of key pests, sampling procedures and realistic crop loss assessments based on unit area and(or) crop unit, received priority as the basis for future evaluations of economic thresholds. An attempt was made to develop techniques that can be easily taught

and used by cultivators to assess their problems since technical personnel to do the job will not be available in the near future. Improved technology is now available on cabbage, egg plant, melons, mustard, pulses, cotton, potato, and mango. Research is continuing to further define and refine methodologies on these and additional crops. It was demonstrated that the IPM approach reduces pesticide applications from a recommended seven sprays to only one in cotton, from three to one in mango, and less than 20% in the crop of cabbage. Use of sprays were avoided altogether in 2 years for chickpea with insignificant crop loss through monitoring for gram pod borer.

Insecticide toxicology was recognized as an area of research in need of development. The toxicologist at the National Crop Protection Center in the Philippines assisted in developing plans for a unit at BARI to do research on pesticide residues and toxicology. This included plans and proposals for laboratory renovation, equipment, staff training, and research programs.

2. Staff training and development included local and overseas degree training, study tours, local training workshops, and individual, in-service staff training on pest identification and research techniques.

One entomologist and one plant pathologist completed M.Sc. degrees at UPLB, the Philippines and a third scholar is currently studying there for the M.Sc. in vertebrate pest management. One scholar deputed to the United States for an M.Sc. in vertebrates completed a Ph.D. in the prescribed time allotted and returned to BARI.

One each M.Sc. and Ph.D. scholars are receiving support for in-country degrees in plant pathology at DU and BAU.

A scientific officer, trained in toxicology received 6 weeks of training in pesticide residue analysis at the National Crop Protection Center at Los Banos, Philippines.

A training workshop on Principles of Integrated Pest Management was held in January 1985 for 24 participants from BARC, the research institutes, universities, and agricultural extension. The participants (senior level officers) were selected to provide a core group of personnel for future training and research activities. One of the workshop activities was the development of "An Integrated Crop Protection Program for Sugarcane Production by Gur Farmers." This was synthesized from available technology in Bangladesh. Unfortunately, funding was not made available for implementation of the program.

An ad hoc committee of scientists, that participated in the workshop, was constituted to develop a Bangladesh Crop Protection Plan based on principles of IPM. A draft plan was completed in December 1985 following numerous meetings to define the format and components of the plans. It presents a realistic appraisal of the current status of research, identification, and priority of problems

with potential and given a time frame for solution. This provides BARC a document for budgeting and funding of crop protection research.

Specific topic training programs were held with the assistance of expatriate consultants: 1) plant disease diagnostic clinics were held at BARI and its RARSs and at several universities to acquaint scientists with technical aspects of identification and problem solving; 2) banana tissue culture techniques for maintaining specific pathogen free clone for propagation of bananas; 3) pesticide use and safety; and 4) statistical methods for entomological research and evaluation of data.

The specialists worked with individual scientists at BARI to improve their capability in cotton, pulse, maize, mango, mustard, and vegetable insect research and in management of soil pathogens and nematodes in upland crops.

3. The Entomology and Plant Pathology Divisions at BARI and the RARS were provided with research equipment valued at $193,401.44. This provided these divisions with the basic tools to do field and laboratory research with the exception of the insecticide toxicology laboratory. Some additional items, such as a Gas-Liquid Chromatograph unit will be needed to complete this laboratory. Transport is needed by both divisions.

   Renovations of the Entomology and Plant Pathology Divisions provided discrete office and research areas that improved capability for individual research programs.

   A glass-covered screenhouse/insectary/headhouse facility was constructed at BARI to provide work areas for host plant screening under controlled conditions. This is especially useful for work in the kharif season when excessive rain often inhibits certain research activities. It will also be invaluable in maintaining insect cultures for toxicology and biological studies.

5. FUTURE WORK

5.1 RESEARCH SYSTEMS MANAGEMENT

Achievements in improved management have created a general sensitivity throughout BARC and the constituent institutes on areas for further attention. These are summarized briefly, as follows:

- Physical Infrastructure: Need to increase mobility of scientists through provision of additional vehicles, plus continued attention to maintenance and provision of spare parts.

- Human Resources: Continued monitoring of development of personnel through training of scientists, technicians, clerical and other support staff. This will require refinements in the databases and selective recruiting to fill gaps in staffing the research system.

- Personnel Management: Further attention to management of personnel throughout the system, particularly with respect to position descriptions, salary schedules. and analysis of training needed to maximize performance. Other improvements would include integration of databases among institutes and BARC and publication of personnel manuals.

- Program Management: Given the BARC goal to operate as a system for coordination of the activities of the research institutes within the research network, additional work is needed to help the institutes perceive the national needs in research, outline the objectives, gather financial support, monitor progress, and recommend further action.

5.2 TECHNICAL SUPPORT SERVICES

5.2.1 Farm Development

Service for All Institutes

Efforts in farm development were concentrated at the BARI headquarters and regional stations. As a result, the other institutes affiliated with BARC received only cursory assistance in this area.

Lack of a Counterpart

The specialist had no official counterpart; therefore, when he departed post after the agreed 36 man-months, the efforts made to strengthen farm development came to a halt. The appointment of an official counterpart was the obligation of the host country. This is necessary to maintain continuity in the program. The lack of an official counterpart to carry on after the specialist's departure derailed the initial success of the program.

The farm development program, initiated as a result of the ARP-II program, should be continued. The various institutes should nominate individuals who can carry out the activities based on the farm management procedures document held in the farm division at BARI, Joydebpur. The farm management support service activities should be directed from a single source to increase their efficiency and should have proper direction. The central source should be assigned as a duty of a member-director of BARC.

Personnel working in farm development should have the same opportunities for training, both in-country and overseas, as those available to personnel in research programs. At present, support services personnel are regarded as "second class citizens" in the research system. This hampers their performance; yet, the research system cannot function efficiently and adequately without them.

A master plan for the farm development section should be prepared. Development activities of the section should be planned to allow the flexibility of phasing out areas in the plan, that eventually shift to a lower priority. Annual development plans should embrace activities of high priority indicated in the master plan.

5.2.2 Maintenance

Transport and Farm Machinery

Systems of maintenance of transport and farm machinery for all institutes associated with BARC: Due to the fact that initially the maintenance specialist was assigned to BARI, the maintenance system designed and put into operation was solely for the BARI Repair and Maintenance Section. All ordering of parts, instruction, and construction was done within the framework of that institute. The other organizations associated with BARC did not receive the benefit of this program. To be absolutely effective for Bangladesh agricultural research, all institutes should be recipients of the program. This is why it is imperative that BARC assume leadership and responsibility to initiate, guide, and support a program with the main center of excellence at BARC. The BARC maintenance center should be under the administrative direction of the member-director (Ag. Eng.) who would be responsible for the maintenance program within the BARC framework. He should be given sufficient trained personnel to assure the program is carried out effectively. The system used at BARI can serve as a model and guide for other institutes.

Central inventory and ordering: The advent of the central maintenance center will allow the system of central ordering and inventory to be employed. This system will allow ordering and delivery of spare parts and the distribution of these to the appropriate institute or station. These parts and(or) equipment can be inventoried before being sent. This will allow much of the record keeping to be done at BARC rather than at each institute. These inventories together with repair records can be used to determine the efficiency of operation of any unit. Furthermore, reordering can be done in a systematic manner to guarantee that a stock of spare parts will always be available. In order for this

system to be effective, it must be enforced that all ordering be done through the central maintenance center.

Continued training: The need for continued training of personnel is of utmost importance. This can be done by in-country training using consultants or local personnel trained in a particular discipline.

Laboratory Electronic Instrumentation

Counterpart in the electronic maintenance: The specialist's main purpose in Bangladesh was to establish a workable maintenance and repair program for the scientific community, manned and operated by Bangladeshis. This could only be accomplished with the actual participation of Bangladeshi personnel. A counterpart for the specialist must be placed in the system to allow continuity in the instrumentation and maintenance program. The operating head of the BARC Electronic Instrumentation Cell should be a senior scientific officer (SSO) at the start, with promotion to principal scientific officer (PSO) as his responsibility increases. This individual must have training in electronics and use of the various scientific instrumentation. He must not only be familiar with electronic circuitry, but also have a working knowledge of the various units used in scientific research.

Concentrated in-country training of electronic personnel: This program can only be successful by training a select group of persons with the proper aptitude, attitude, and scientific training to enable them to become the nucleus of a BARC electronic instrumentation cell. These individuals should form the framework of an instrumentation repair and maintenance group available to the various institutes, allowing BARC and its associated institutes to be self sustaining.

Center of electronic maintenance located at and supported by BARC: BARC should be the center of maintenance in the agricultural community of Bangladesh, since it encompasses the affiliated institutes and can exercise some control over these units. If each institute were to embark on its own maintenance program, differences in instrumentation used and quality of service would be enormous with no resemblance of any type of uniformity. This type of action would only result in failure. It must be a concentrated effort by a central unit such as BARC.

The central facility for scientific maintenance would have a greater responsibility than the repair of instrumentation. A variety of operations would be involved to cause a more efficient operation in agricultural research. These operations should be:

- serve as a resource to the institute maintenance specialists in cases of difficult repair operations

- central inventory of all scientific instruments and apparatus in the BARC affiliated institutes

- to facilitate procurement of instrumentation to ensure units ordered will adequately perform operations the investigator wishes to accomplish

- to procure spare and replacement parts for the institute and laboratory maintenance specialists; this will require close cooperation with the various donors of instruments

- to serve as a depository for the operation and service manuals of the instrumentation in the affiliated institutes of BARC; BARC in addition should house a library of technical data information books

5.2.3 Training Division

Objectives Setting

More regular meetings within the training division to set work targets and to review progress would be a discipline to keep every one informed and assist in monitoring achievements and resetting priorities. This practice would be useful as a means of on-the-job training.

Information

Courses. The division has some information on training available outside the country. More information could be gathered on institutes abroad, particularly in south and southeast Asia and other Third World countries, concerning availability and content of training offered.

Management development procedures. As a result of changes in rules and regulations and in reviewing working experience, the handbook on management development procedures was being updated in greater detail for short-term training. This needs to be continued for all training and republished for a ringbinder system which can easily be amended at appropriate times.

Guidelines. Although procedures are published and forms designed for people to complete, there is not much information on "how to do" some things concerned with training. It would be worthwhile to publish and issue some guidelines on techniques/practices for managers who have some responsibility for training and manpower management.

Guidelines would be useful on

- assessing training needs
- planning training
- on-the-job training
- setting up and running a course
- manpower planning

Training Planning

- The annual planning system for training was being reviewed. This should be tested and modified as necessary so that it links in smoothly to the National Training Council requirements. It should be designed to ensure that individual sporadic requests for training are reduced to a minimum or eliminated so that the training division can work more effectively on administering the annual training plan.

- Planning for all nondegree training should be improved as the amount to be handled will substantially increase over the next 4 years. Detailed systematic planning will help the division manage more and different types of work at one time.

Manpower Planning

Following publication of the present draft report, the following action should be taken:

1. discussions to be held with individual institutes on the manpower report and action points to be agreed

2. discussion to be held at BARC on the manpower report and action points to be agreed for taking up with the Ministry of Agriculture

3. institute manpower plans to be reviewed after approval and manpower and training plans updated

4. data on scientists and technicians to be checked and updated with all institutes except BINA and FRI which have already been started

5. technicians data to be analyzed and reports to be produced

6. information on data of all support/administrative staff to be collected and put into computer

7. data on support staff be analyzed and reported on

8. system of institutionalizing automatic updating of information on manpower between BARC and institutes to be completed

9. guidelines on manpower and training planning to be written, approved, and distributed to institutes so that manpower and training planning become systematic processes

10. on-site briefing at all institutes on the guidelines in 4 to 9 above.

11. all present data on the computer filling assistant program to be converted to "dBASE" program for increased flexibility in outputs

12. additional data on all staff to be collected, e.g., salary for manpower costing

Implementation of Training

This should be significantly helped in the nondegree training area by the April 1987 change in rules for the issue of government orders for training abroad. As a result the system has changed, but the new system must be tested and improved to ensure it is as efficient and effective as possible.

There is a substantial amount of in-country training to be implemented. The ability of the various institutes to handle particular courses and to confirm what they have to offer over the next year needs to be clarified against funds available. Decisions then need to be taken on priorities, allocation of funds and appropriate delegation for implementation.

Monitoring and Evaluation of Training

The increasing workload in the training division in planning and implementing means that monitoring and evaluation has not been dealt with effectively. The present system can be improved further but staff needs to be increased to even contemplate doing a reasonable job of this.

Staffing

The present and future workload of the training division is such that the quality of administration and standards expected across all the types of training, funded by present and future donors, cannot be improved or maintained at present levels unless professional staff is increased.

An increase in staffing will result in reorganization of work and the need to review the style of managing the division. To adapt to the growing needs, it is likely that more formal meetings covering work targets for staff, more delegation, and monitoring of achievements will be required.

Further training should be given on the microcomputer to division staff including typists.

The institutionalization of the manpower planning system within the training division requires additional staff time on a permanent basis and organized technical support from the BARC Computer Center.

5.2.4 Agricultural Information

It is essential that NALDOC staff trained in the various aspects of computer processing continue to use and learn about software packages available. Only in this way can necessary familiarity be developed. Now that over 1,000 records have been added to the in-house database, emphasis must be turned to actually using it for answering queries and compiling bibliographies. The narrow view of the system as a means by which a typist can input AGRIS data for onward transmission to FAO must be radically altered. The database should become the first and most important tool for all NALDOC's bibliographic work. The training implications of all this are obvious.

The IBM-XT presently used by NALDOC has a 10 Mb hard disk capable of storing about 2,000 AGRIS records. This is equivalent to 2 to 3 year's input to AGRIS by NALDOC. However, this does not allow data acquisition (e.g., records obtained from FAO for BAB processing) or other activities, such as the Irrigation and Water Management Bibliography.

It is therefore essential that consideration be given to purchasing an IBM-AT with a 40 Mb disk for NALDOC's use in the near future. To ensure adequate and efficient backups, a tape streamer or Bernoulli box would also be essential.

Naturally, all this can only really be achieved if the new IBM-AT is easily available to NALDOC staff, i.e., in their own office. It is hoped that this will be possible in the new building now approaching completion.

A particularly annoying problem experienced by NALDOC and other libraries in the research system is loss of many single issues of journals in the mail. A service involving collection of journals in Singapore, followed by air-freighting to a local agent in Dhaka for delivery to clients, would appear to overcome this. This service is currently being used for the supply of a large number of journals for IPSA, and appears to be working well. Future subscriptions to journals should be consolidated with the Singapore subscription agency to ensure safe delivery to libraries in Bangladesh.

The Bangladesh Agricultural Information Network (BAIN), consisting of the libraries in the national research system, exists in name only. NALDOC must be encouraged to develop systems and services justifying their central role in BAIN. One simple way this could begin is for NALDOC to coordinate other network member's use of AGRIS. Monthly current awareness printouts and retrospective bibliographies are available free of charge to NALDOC as the national AGRIS input center. Similarly, if NALDOC were to improve the much discussed system of circulating copies of journal contents' pages to research workers throughout the system, their credibility and prestige would be considerably enhanced.

Communication

The major constraint in the publications area throughout the entire project was the lack of a counterpart for the communication specialist. The difficulty of running an effective publications program at BARC without a communication unit was pointed out in consultants' reports even before the appointment of the communication specialist. If real progress is to be made in the future, it is essential that BARC employ a local counterpart who can work with a specialist to build up communications capability.

5.3 FARMING SYSTEMS RESEARCH

Training in farming systems research methodology must be conducted at FRI and LRI as an integral part of their staff development before much technical support can be provided in the specialty areas of livestock and agroforestry.

One of the mechanisms for ensuring a balanced multidisciplinary FSR approach, involving each of the subsystems of target group farms, is to promote attention on homestead production. It is in the homestead that

agroforestry, livestock management, the role of women's labor, and subsistence vegetable production are integrated.

Attention must be given to the interaction of technical innovations on resource allocation (land, labor, and capital) during the pilot production stage of technology testing, where screening is done by farmers themselves on entire fields rather than on small plots. Instruction must be given to FSR researchers on parameters to evaluate during these whole farm case studies. Additional training will be needed for monitoring the diffusion of technologies throughout a farming population (adoption studies).

The National Technical Coordinating Committee at BARC must take a much more active role in visiting each FSR site and monitoring technical reports and work plans, so that a comprehensive national FSR report can be compiled each season. An annual FSR workshop or similar forum involving all participating institutions should also be implemented for discussing strategies, progress, and interinstitutional collaboration.

The National Technical Coordinating Committee at BARC is also in the best position to write a seasonal or bi-annual FSR Newsletter for distribution to all participating institutions. Contract research staffing in ARP-III should consider the need for a communication specialist to help document and transfer information between sites and institutions.

The FSR efforts of commodity oriented institutes, such as the BJRI, SRTI, BRRI, etc., will require encouragement to incorporate a FSR perspective into their current cropping system research programs. In light of inadequate training and staffing at LRI and FRI, training activities may also be necessary in the short-run to prepare existing staff of each FSR site to conduct research on livestock and agroforestry subsystems.

Microcomputer data storage in a standardized format will also be necessary for future data retrieval and analysis, such as in the evaluation of technologies over sites and seasons. When the IBM-XT computers are distributed and personnel trained to operate them, diskettes with data collection formats should be distributed to each regional field location to encourage this activity.

In preparation for continuation of a farming systems program, the following constraints present in ARP-II need to be addressed.

- Funds were not released in a manner which facilitated smooth operation of FSR in-country training programs. Consequently, only two training workshops were conducted during ARP-II for higher level staff from participating institutions. Training of junior level staff and field assistants, who do the majority of data collection, was inadequate. BARC must solve this problem.

- Delays in obtaining government approval for overseas workshops and training courses forced cancellation of three study tours to visit FSR programs in neighboring countries and prevented training of

eight other scientists from BARC, BARI, BJRI, SRTI, LRI, and FRI in farming systems research at IRRI. This must be changed in the future.

- Similar problems with government clearances caused several delays and cancellations of short-term consultancies for ARP-II project development. Such delays must be overcome before future financing is given.

- Initial difficulties in staffing multidisciplinary teams at each FSR site, as well as staffing coordinating units of CSR and FSR, were experienced. Recruitment is still underway to staff each FSR site with livestock specialists. A complete FSR team is needed at each site.

- During the transition from cropping systems to farming systems research, technical deficiencies were encountered in the LRI and FRI. As a result, most on-farm experiments conducted at those locations focused on cropping subsystem. This emphasizes the need for a complete well-trained FSR team at each site.

5.3.1 Joydebpur

The farming systems research methodology course should be continued to train FSR scientists of OFRD-BARI and scientists of other institutions engaged in farming systems. Some international institutes have developed FSR training modules and tutorial slides. These training guides should be reviewed to allow relevant materials to be incorporated into the Bangladesh FSR training modules.

Much has to be done by BARC to improve and streamline the release of contract research and training funds to the institutes so that money reaches end users on time.

The continuing multilocation testing programs at the different extrapolation areas of the BARI FSR sites will come up with properly validated and better performing technologies. This then has to be expanded into the production program phase with extension division personnel spearheading the program.

Pilot production programs at the different sites should generate enough information on how to overcome constraints in implementation. They should then be expanded into district and(or) regional production programs.

Other FSR sites will be generating technologies which will go into the preproduction evaluation phase. Planning and implementation of the program should be guided properly and be closely monitored. Much can be gained by looking at experiences from other sites which have conducted multilocation testing and preproduction programs.

5.3.2 Jamalpur

Future work relating to FSR is detailed in the document Farming Systems Research, Jamalpur -- Extrapolation Area, Constraints and Potentialities, Objectives, and Strategies. Briefly, the major items of work to be undertaken, besides ongoing studies are

- fertilizer recommendations on a cropping pattern basis
- inclusion of legumes and green manure crops in cropping patterns
- improve soil fertility and productivity through improved organic and inorganic fertilizer management practices
- diversify vegetable cultivation by including new crops, improving varieties and staggering planting dates so as to increase and ensure an equitable distribution of income throughout the year and a more balanced nutrient consumption by farm families
- improve management and production of aroids, one of the most popular homestead crops among poor farmers
- increase income from b.aus areas by improving technologies or by adopting alternate crops
- evolve low input, high return, stable cropping patterns for small farmers
- diversify and increase production of trees at homesteads by improving fertility, pest management, and rejuvenating unproductive trees by practices such as pruning and grafting better varieties; emphasis to be on fast-growing trees compatible with livestock and higher biomass production
- improve cattle nutrition by supplementing cattle feed with molasses and mineral mixtures
- genetic upgrading of poultry using the Rhode Island Red breed
- improve production and decrease mortality of cattle and poultry by preventive veterinary care

There is scope to further strengthen linkages and interactions between on-station and on-farm scientists, and also between discipline oriented scientists. In many disciplines, the degree of supervision and involvement by BARI headquarters senior scientists in work at the regional stations leaves much to be desired. In certain disciplines, posting of scientists at regional levels and work related to regional needs are inadequate. These aspects were repeatedly emphasized in recommendations made at regional internal review workshops.

Generally, scientists do not like working at the regional stations. Unfortunately, there is a feeling among them that those working at BARI headquarters benefit from quicker promotion and obtain more scholar-

ships. The need to regionalize research cannot be over emphasized. Therefore, incentives such as opportunities for scholarships and promotional prospects should be biased in favor of scientists working at regional stations.

For about the last 3 years, the position of CSO and station PSO remained vacant at Jamalpur. The post of SO (farms) was not filled for several years. Under the circumstances, the senior-most PSO was in charge of the station as well as having his own discipline-related responsibilities. Consequently, the management of the station and the PSO's discipline were adversely affected. This anamoly should be rectified without delay.

Activities related to ARP-II were heavily in favor of BARI. Needless to say, institutes like BJRI need considerable support. In cropping systems, rice and jute are the major crops of the region. But adequate inputs from scientists of these institutes were not forthcoming in planning and evaluating FSR. This aspect was also repeatedly stressed in recommendations emerging from internal review workshops. Indeed, linkages between commodity research institutes were minimal. However, significant linkages were established with BAU, especially in work related to the livestock component in FSR.

5.3.3 Ishurdi

In coordination with the Bangladesh Agricultural Research Council, ARP-II established a basic foundation for cropping systems research at Ishurdi.

The initial work to allow integration with other subsystems started but a continuing effort is required for a further 3 years, in order to generate a substantial amount of appropriate FSR technology.

Emphasis should be given to the following aspects in the future.

Research and Training

- introduction of a "whole farm" research concept at FSR sites
- introduction of livestock, fishery, and agroforestry field experimentation at FSR sites
- strengthening research on homestead vegetable gardening for landless and other farmers
- intensifying research on the residual effects of fertilizer on a cropping pattern basis
- providing multilocation testing of proven economically viable cropping patterns of FSR sites
- introduce a preproduction program of proven cropping patterns at FSR sites

- preparation of a field experimentation manual for on-farm research
- publication of proven technologies of FSR as extension bulletins in simple Bangla
- training of extension workers on FSR proven technologies
- organize an international farming systems symposium
- emphasize component technology testing of chickpea, mungbean, maize, mustard, sunflower, and groundnut at on-farm MLT sites
- strengthen vegetable and fruit research activities
- establish firm linkage with the Indian Council of Agriculture Research for their materials, IITA for cowpea materials, AVDRC for mungbean, and ICARDA for lentil technology
- intensify research on production and management of chickpea and other crops to minimize the gap between experiment station and farmers' yields
- research on sulphur, zinc, and boron nutrients in the soil should be done as a special project
- prepare VTR film on available technology at RARS, Ishurdi, and other FSR sites
- improve technical competence through degree training programs for scientific and senior scientific officers
- train SOs and SSOs at international institutions such as IRRI, ICRISAT, and IITA on farming systems techniques
- senior scientists should participate in international conferences in order to keep up with current FSR achievements

5.3.4 Jessore

Many activities must be undertaken in the future to sustain the farming system research effort in the Jessore region. These include

- Continued generation of crop production technology.
- Integration of homestead and livestock aspects in farming systems research.
- Intensification of technology transfer and research/extension linkages.
- Starting a pilot production program b.aus/jute -- t.aman -- potato in the FSR site. Research at the station should continue to reflect conditions under which crops are grown in the farmers' fields; for

example single or mixed crops, row-sown or broadcast, relay or intercropped, etc.

- The SMOs should attend the RTC meetings and report on activities at MLT sites.

Physical Facilities Needed at the Jessore RARS

- additional land of about 20 hectares for field experiments
- periphery wall for the research station
- sheds for tractors, vehicles, and other farm machineries
- field laboratory
- building for additional offices
- residential quarters for the production specialists
- additional building for a guest house, mess hall, and kitchen
- two greenhouses (pathology and entomology)
- paving of research station roads
- inclusion fence for meteorological equipment
- installation of culverts to provide tractor access to fields

Equipment Needed

- 2 power tillers
- land leveler

Repair Work Needed

- Ferguson tractor
- power tillers
- blue pick-up

5.3.5 Hathazari

Cropping systems research is at a peak so the continued strengthening of farming systems research is essential. An integrated project of crop/livestock/fishery/agroforestry should be introduced at the FSR site as this is an ideal location for that purpose. Multilocation testing should be intensified. Pilot production programs at more locations should be introduced. On-station research on cowpea, maize, tomato, cabbage, true seed potato, betelnut leaf, avocado, and mango should be intensified.

Fortnightly seminars were organized to develop the capability of research scientists in organizing their research results, developing better writing habits and presenting scientific papers. These types of programs need to be continued and diversified.

5.4 ECONOMICS AND SOCIAL SCIENCE

Three broad areas need to be developed in future work: human resource development, ongoing research, and constraints.

Human Resource Development

The institutionalization of short training courses needs to be continued. Only the descriptive statistics course was institutionalized at GTI/BAU, BARD/Comilla, and RDA/Bogra. Two other institutes were in the process of developing the course: BJRI and BAI. All institutes need further financial support and encouragement to consolidate training in this area.

Further, other courses in the suggested sequence of courses (descriptive statistics, elementary probability statistics, sampling, matrix/calculus, multiple regression, report preparation, and microcomputer usage) should be institutionalized as soon as possible. Most agricultural researchers cannot perform a statistical test. Most don't understand proportional random sampling. Most have not had simple matrix algebra. Hence the need exists to continue to present these short courses and to train trainers at various institutes and then to encourage these institutes financially and physically to develop the courses.

Participants should be chosen for each course on the basis of participation in preceeding courses. As much practical instruction as possible should be emphasized using local data. Instruction should include as much discussion in Bangla as possible. Finally, much more effort needs to be placed on course follow-up. Are the people using the material learned in the course and if not, why not? Is the course practical enough, were the right participants selected and(or) are they located in positions to use the training effectively? This follow-up would provide good feedback information to the Training Cell of BARC.

Once the agricultural economists have taken the above sequence, they are then in the optimum condition to take a further series of short courses in the economics area, i.e., price analysis, project analysis, rapid rural appraisal, and the use of microcomputers. They will also be in a better condition to enroll in overseas degree programs.

A serious attempt should be made to encourage continuation of the AESS workshop series on the analysis of FSR site data. This series encourages field staff to use materials learned in short courses and to prepare and present technical papers using field data. As such, it attempts to develop a sustained capability in the research system.

BARC should encourage other program areas to develop similar workshop series and(or) encourage them to join the AESS FSR workshops; thereby widening their scope and participation. This would most likely require participation of expatriate specialists to encourage and assist research personnel in preparation and participation in these workshops.

Ongoing Research

Agricultural economic research at present is dependent on personnel attached to the OFRD and AED, BARI; the FSR unit of BJRI, personnel in BARD, RDA, BAU, and other universities.

A number of technical papers have been completed (23 in the AESS workshop paper series). By drawing up a balance sheet for each FSR site, a list of priority topics that need to be studied can be developed for these sites.

In the area of contract research, priority research topics have been selected in several program areas. More emphasis may need to be placed on policy related macroeconomic research, social anthropology such as adoption of new technology studies, resources allocation studies such as land use and farm management, livestock economics, and others. Current methods of evaluating and monitoring need to be strengthened. The role of the expatriate specialist in this process needs to be further specified. An experienced specialist could be very useful if given the opportunity.

Finally, the AESS program area technical staff should be encouraged to carry out economic policy studies. The capacity to do this will depend on staff, training, and work loads. An expatriate specialist can assist in this area. However, ideally, internal capacity to do this should be encouraged and developed.

Qualitative constraints such as the shortage or even absence of agricultural economists in the system have been documented. Regularization of contracts for SOs agricultural economics, and their status at research stations and slow release of funds for contract research and training were previously pointed out. Changes need to be made to remove these constraints in the future.

5.5 CROPS RESEARCH

5.5.1 Agronomy

There are five important points for consideration for future work in agronomy:

1. Coastal salinity -- land reclamation by construction of dikes (poulders) provides needed land for cultivation. However, in many of these areas there is salinity build up to toxic levels in the post-monsoon season. Research on crops and cropping practice adaptable to these conditions is essential.

2. Testing -- agronomic practices, cropping patterns, fertilizer rates, etc., on an on-farm basis should be practiced more frequently and early in the research program.

3. Barind tract research -- early decisions are needed on approaches to be taken in this area. Careful consideration should be given to doing appropriate research at existing regional or substations rather than creating a new separate station. However, future work should include a major effort in the Borind.

4. Training -- out-of-country training programs, both short-term and graduate training, continued to be seriously hampered by government

policies regarding identification and selection of trainees and granting approvals to leave the country. Improvement is needed. Policies need to be standardized and streamlined.

5. Experiment station research -- many constraints at various station and substations still make it difficult or impossible to conduct field research with precision and adequate error control. This is especially true of BARI's main experiment station at Joydebpur and at some of the substations.

   Factors contributing to the situation are

   - poor drainage
   - land not leveled
   - low soil fertility, including the micronutrients
   - poor soil physical condition
   - lack of competent and adequate trained manpower (in some areas)
   - inadequate operational funds
   - lack of groups of trained scientists to develop strong interdisciplinary teams for various commodities (particularly at the substations)

5.5.2 Crop Science

In the area of crop science, most future research should emphasize food legumes (pulses) and oilseeds, and should consider the following points:

1. **Research coordination and division of responsibilities.** Research among/between BAU, BINA, and BARI is not well coordinated. Improvement is needed. There are many oilseed and pulse species of importance in Bangladesh. Each institution cannot conduct research on all species. Research responsibilities should be divided among the three institutions, i.e., BARI should be responsible for research on only some of the species with BINA and BAU each accepting and dividing responsibility for conducting research on others.

2. **Maize.** Research and well conducted evaluation missions indicated that maize has tremendous potential for Bangladesh. Well-conceived strategies for research and production programs were formulated. Bangladesh now needs to get on with it. A detailed project document needs to be developed, a donor agency(s) needs to be identified. All aspects of a balanced (production, processing, utilization, marketing, socioeconomic considerations, etc.) program must be launched.

3. **Soybeans.** Limited research on soybean production, village level processing, and utilization was conducted. Soybeans yield well in Bangladesh, appreciably higher than any of the other food legumes (pulses) and oilseeds. More detailed and comprehensive studies need to be conducted. All aspects (production, processing, marketing, utilization, seed production, and seed quality, etc.) need to be considered. Home level versus intermediate level versus commercial processing should be carefully analyzed. Private sector

participation should be considered. Within a few years Bangladesh should be able to determine the true potential of this very important, protein (40%) and oilseed (20%), crop.

4. **Seed production and seed quality.** The seed program needs strengthening. Breeders need to be in a better position to supply high quality breeders seed to BADC in sufficient quantities. Seed of promising local cultivars should be purified and multiplied. A good, continuous, and carefully controlled seed multiplication program for the pulses and oilseeds is needed.

5. **Seed storage.** At most research stations and "seed farms" improved seed storage facilities are needed, including temperature and humidity control. Improved seed processing plants for some of the oilseed and pulse species are needed.

6. **Variety trials.** Additional multilocation trials are needed to determine where new varieties of khesari, lentil, chickpea, maskhalai, mungbean, groundnut, mustard, soybean, etc., perform well.

7. **Germplasm.** Additional germplasm should be procured through contacts with national and international institutes such as ICRISAT, IITA, AVRDC, CIMMYT, CIAT, IRRI, and ICARDA.

8. **Regional cooperation.** Bangladesh is encouraged to be much more active in the regional project RAS/82/002, TCDC for Research and Development of Food Legumes and Coarse Grains in the Tropics and Subtropics.

5.5.3 Horticulture

1. The vegetable industry of Bangladesh is seriously in need of readily available quality seed on a seasonal basis. The home garden growers throughout the nation require packet size samples with moisture proof packaging, containing past season's viable seed. Seed sold from bulk containers is often nonviable. In a nation lacking adequate communication this presents a difficult problem. Locally grown seed generally does not meet adequate sanitation standards nor is there any guarantee of variety or adaptation. Of numerous locally grown Chinese radish seed samples collected from retail outlets last fall, most went directly to bolt rather than forming roots during controlled tests.

   Recommendations from a western specialist that some varieties of vegetable seed cannot be grown commercially in Bangladesh are not seriously received. The proper channel for correcting this problem would be to train local technicians in areas where seed production is an established art. Western nations have struggled for many years to remove the bolting habit from numerous crops, but some practices in Bangladesh seem to be restoring this unacceptable trait.

2. There is need to provide the vegetable section at BARI with land suitable for production and variety trials. Future projects should consider provision of a van for daily travel to a suitable government farm near Joydebpur where well drained productive soils are available and meaningful trials can be conducted.

3. The past seasons efforts to determine the most suitable hand pump for Ishurdi home garden use indicated some modification of the rower pump was merited to facilitate its use by women and children during the low water level period. Continued cooperation with M.C.C. to resolve this problem appears worthwhile. The alternative is to use the No. 6 pump which is not maintainable by the farmer, has a low discharge rate, and is more costly.

4. Future work and self sufficiency in food production are highly dependent on the educational ability of the researchers involved. It is essential that a continuous contingent of students be placed in a position to learn, understand, and transfer modern vegetable farming techniques to Bangladesh.

5.6 LIVESTOCK RESEARCH

General Recommendations

The continued importance of livestock should be stressed in future agricultural research and development projects because of its total integration with existing farming systems of Bangladesh and the direct link to most small farmers' income, nutrition, and welfare. Over 90% of the draught power for crop production; a substantial amount of power for transportation of goods, meat, milk, and eggs for human consumption; hides, bones, and horn as raw material for industry and for export; manure for crop fields; and fuel for domestic use are derived from the country's livestock and poultry.

Both livestock and poultry are fed mostly on crop by-products and residues having little alternative use for human beings. Almost 90% of rural families are involved in backyard livestock production of goats, sheep, and poultry scavenging on crop residues and household wastes. There is practically no specialized commercial livestock production in the country. No land is devoted strictly to stock feed production; and, forage or fodder crops are hardly ever included in cropping systems. Scarce feed supply is the key restraint in use of cattle for draught purposes and for milk production.

Estimates available at present indicate that cattle subsist on less than 3 kg per head per day of rice straw and weeds supplemented by meager roadside grazing plus 30 to 40 grams per day of bran or oil cake when available or when the farmer can afford it. A simple straw diet fed ad lib is hardly acceptable for draught bullocks and has disastrous effects on growth of young stock and on fertility levels and milk yields of cows, especially when used for draught purposes. Recent surveys indicated that roughly three-fourths of all draught cattle on farms under 2 acres are cows. Because of poor nutrition, particularly at the

end of the rainy season, draught animals are ill-prepared for the heavy work of land preparation. This results in late and inefficient crop cultivation which adversely affects crop yields. Despite the importance of livestock in agricultural production in Bangladesh, much less attention has been given to research on livestock problems than to the crop sector.

While considerable progress was made toward building a livestock research infrastructure with formation of the Livestock Research Institute, much remains to be done. Technical and managerial guidance is still needed by LRI to

- implement the planned "on-farm systems research program" in cooperation with other institutes

- train and orient LRI livestock scientists in this new approach

- promote on-farm livestock systems research at the "government policy maker" level to assure support for the institute

- continue to build a useful livestock research library

- facilitate installation and use of laboratory equipment already purchased as well as that to be ordered through the I.D.A. project

Until formation of the Livestock Research Institute, livestock research was fragmented, based on little knowledge of farming systems, mostly unrelated to smallholder animal production and efficiency problems and of little use to farmers. As a result, less attention was given to livestock than crops in development plans by policy makers including both governmental and external aid sources. Problems in livestock production were not well-defined and solutions were not tested at the farm level. There was little incentive by researchers to do good, practical research. There is a shortage of well-trained scientists in the livestock field. According to a recent report the Directorate of Livestock Services (DLS) had 2 Ph.D.s and 12 M.Sc.s; the Bangladesh Agricultural University (BAU) has 23 Ph.D.s and 103 M.Sc.s (including those in veterinary science) and the newly established LRI had only 7 Ph.D.s and 4 M.Sc.s. Most scientists at BAU are heavily committed to teaching and their research is largely limited to graduate student theses. There are no scientists trained in livestock systems research, systems modeling, or animal health economics. Funds from governmental sources for all agricultural research have been extremely limited for livestock. This situation needs to be rectified immediately in view of the importance of livestock to Bangladesh agriculture.

The need for multidisciplined scientists to do livestock research proposed by LRI will require both in-country and overseas training. Much of that can be short-term on-the-job, but a significant amount must be degree training. LRI alone expressed the need for 18 Ph.D. and 26 M.Sc. degrees from overseas universities and 9 Ph.D and 14 M.Sc. degrees locally. Proper selection of the overseas universities to assure an interdisciplinary program dealing with practical, developing country small farmer problems is essential. Further, it will be necessary for

the various faculties of BAU to reach agreements on permitting interfaculty study and research programs to develop the kind of training needed for interdisciplinary systems research students.

Livestock research training of extension personnel in DLS and crop scientists with cooperating crop institutes will also be required in order to have useful exchange and feedback between and among all cooperating researchers, including the farmer himself.

Institutes such as DLS and BAU involved in livestock research should also be supported by contract research funds to encourage full use of their expertise and laboratory facilities, the likes of which will not be fully developed at LRI for many years. DLS should continue to be closely involved with animal health research due to both their extensive field contacts and laboratories. While BAU must always be primarily concerned with education, their professors should be encouraged to develop graduate student research programs to identify problems on the farm, propose solutions and research those judged most appropriate by prescreening tests.

Future activities being proposed involve close cooperation between and among scientists of diverse disciplines: animal production, veterinary medicine, agronomy, agricultural economics, statistics, and extension. In addition to the contract research funds suggested above, technical counseling and on-the-job guidance is recommended. There remains much "old school" support among Bangladesh livestock scientists to revert to on-station research isolated within each discipline. Because of this weakness and lack of sufficient support at the administrative/policy level, the future project should assure that technical assistance is provided directly or by another donor, to give strength to the system research training and implementation as well as maintaining close counsel with BARC and other policy level contacts.

Accepting the risk of repeating previous recommendations, the following guidelines for future livestock systems research are outlined in the following section.

Livestock Systems Research Methodology

Socioeconomic surveys:

- At each FSR/livestock site, the FSR team should conduct a baseline survey and collect basic production data to establish the relative socioeconomic importance of the subsystems, livestock, homestead crops, etc., of the total farming systems. Problems will be identified and solutions tested for extension to other farmers.

- A national herd dynamics survey should be conducted to establish the effects of various macro-socioeconomic factors on the size and composition of national herds and flocks.

- A national feed supply survey should be conducted to establish the size and quality as well as potential quantity of this natural

resource for determining long-term development plans for the livestock and poultry industry.

- A quantitative marketing survey should be conducted to supplement the good qualitative study recently published by Huq and Huq (1986).

Animal nutrition:

- Treatment of straw with urea or urine to improve digestibility and preservation, increase crude protein, and total intake, should be studied at the farm level.

- Cooperative research needs to be conducted with crop scientists to identify HYV of rice and wheat that have both high grain and straw yield and quality.

- By-product supplements, such as rice bran, oil meals, fish meal, molasses, molasses/mineral blocks, and other nonconventional feed sources should be studied at the station and farm level to determine practical feeding value, availability, and relative value as feed versus other uses.

- Other supplements which can be grown or salvaged must be tested for their relative value as feed. These include woody legumes, pulses, high density corn, biogas effluent, blue-green algae, Anabaena azolla, other water plants, poultry litter, banana plants, and other nonconventional feed sources.

- The above test of various main feedstuffs and supplements should be conducted in factorial experiments, alternatively measuring effect of nutritional level on calf mortality; draft bullock work performance and weight change; and draft cow work performance, milk yield, fertility, and weight change.

- The agronomic practices of growing the above mentioned forages and supplemental crops must be tested at the farm level and evaluated technically, economically, and socially.

Animal health:

- Epidemiology studies to determine the economic significance of predominant disease and parasites is of first importance.

- A study to determine the need and practicality of Rinderpest eradication is considered one of the first priorities of the epidemiology studies.

- While awaiting results of the epidemiology study it is considered prudent to conduct trials for control of foot and mouth disease in cattle and Newcastle disease in poultry.

- Study of the vaccine cold chain and distribution system is recommended to identify problems and possible solutions.

Animal forage management:

- Draft animal trials are recommended to compare the relative efficiency of bullocks versus lactating cows, single versus pair, traditional yoke versus improved yokes and traditional plow versus improved plows.

- Collection and evaluation of production parameter data on native versus introduced breeds and crossbreeds of cattle, goats, and poultry are recommended at the farm level to determine the relative economic value to the farmer and the nation. Policymakers can then judge the value of expensive breeding programs now being conducted.

- Alternative methods of maintaining and(or) fattening cattle for the holiday sacrifices should be studied in respect to most efficient rations, and class of animal used.

- Study the effect of distance from homestead to field on the use of straw and weeds as animal feed.

- Conduct trials with wood legumes to determine their dual value as a forage for livestock feed and a source of wood for fuel and building. Wood legumes may be able to economically replace straw and dung now bein gused for feed, fuel, and(or) building materials.

Successful conduct of systems research methodology and proposed research projects will require continued and improved cooperation of LRI, DLS, BAU, and the crop research institutes. Coordination of this overall FSR/livestock program will be the responsibility of BARC and donor sponsored technical assistance proposed in the next phase.

5.7 SOIL MANAGEMENT

There is no doubt that ARP-II had a positive impact on the Bangladesh soil management program and that many advances were made particularly in the area of soil fertility. Initiation of work was just started in many other soil management areas. Knowing the dynamic nature of soil should facilitate the understanding that the job is never complete. That as man and nature influence the soil environment, it responds in various ways that need to be monitored, evaluated, or conserved so the soil resource remains an asset for future generations. Thus, continued improvement in all disciplines of soil management is essential.

Naturally, during initial program development, improvements are large and easily recognized. However, as the program matures, less spectacular but nonetheless important improvements can and must be made. This was the state of the soil fertility program. The other areas of soil management were less advanced, therefore, more rapid improvements can be expected in the future.

While it is seldom that one soil scientists is capable of expertise in all areas of soil management, the need for an expatriate full-time technical assistant was recommended by the 1986 internal evaluation.

Types of assistance to be given by this individual and future work for the Bangladesh soil management program are summarized below.

Soil Fertility

- Improve sample handling system from farmer to BARI central laboratory to increase efficiency of this operation.

- Initiate integration of regional laboratories into the national system.

- As BARI central laboratory starts to reach its capacity bringing regional laboratories into analytical function based on information summarized from BARI central laboratory analyses.

- Improve the plant analyses system including sampling techniques, sample handling, and use of plant analysis for fertilizer recommendations with particular emphasis on tree crops.

- Improve data interpretation skills of scientists through training and upgrading computer analytical hard and software.

- Develop a national soil fertility summary using BARI central laboratory's accumulated data. This will help identify problems on an area basis allowing for a more rational approach for integration of the regional facilities and assist in setting regional research priorities and fertilizer distribution.

- Initiate integration of nonfertilizer technical recommendations into the fertilizer recommendation system. This will provide research institutes with a mechanism to deliver recommendations on agronomic practices, crops, varieties, etc., directly to the farmer.

- Improve research efforts to a more in-depth type involving each deficient nutrient element on a priority basis.

Other Areas

Since work in the other soil areas outlined in the achievement section were just initiated, it is obvious that each may need a separate approach to achieve the most impact in the shortest time. These areas include:

- Review ongoing contract research results and modify as needed.

- Have follow-up consultancies by same individuals in each area, as is possible.

- Initiate short-term training in each area on a priority basis.

- Develop long-term manpower development plans for each area including degree training needs.

- Increasingly reassess duplication of equipment and efforts among institutes in order to develop a more efficient program. This is particularly true of BNF work.

General Observations

While much was accomplished in this short 5-year period, continued improvements in the overall soil management program are essential. The importance of this statement for increasing national crop production and economic status of farmers is amplified when one considers that soil is one of the four major factors affecting any crop yield.

A firm foundation was established in the area of soil management. BARC definitely improved its capacity to manage a national soil management program during ARP-II. These positive actions will not likely continue to grow and diversify at an accelerated rate without external inputs.

5.8 IRRIGATION AND WATER MANAGEMENT

The irrigation and water management program made considerable and positive contribution towards promoting the importance of irrigation and water management issues to the country. It strengthened the council in order to assist participating institutes and universities to develop their own programs. However, it was also recognized that such efforts were merely noticeable "dents" considering the overwhelming complexity of issues faced by Bangladesh in pursuing and orderly and efficient development of its water resources.

Before putting forward the tasks that remain ahead, it seems appropriate to document some bottlenecks faced by the program during its implementation. Some of these constraints are not unique to the program, but were general project obstacles. They should be removed or at least minimized in order to obtain a measure of success in future irrigation and water management undertakings.

Specific needs for future programs can be categorized into two distinct groups: i) those generated within the council and participating institutes, the solution of which will provide an enhanced opportunity for improvement; and ii) those generated outside the control of i above, where top management and interministerial factors play a role, and which a higher level of commitment will be required.

Addressing only the first category, the following are worth mentioning:

- Honor final approval of activities in the annual work and financial plan. Unnecessary reapprovals created several postponements or even worse, cancellation of some activities. Once approved, activities should become active programs.

- Ensure the provision of counterparts from BARC, for work with the specialists and expatriate short-term consultants.

- Sustain and motivate the ad hoc counterparts identified from participating research institutes, by reimbursement of transport and food allowances for the duration of the expatriates' consultancy.

- Ensure timely release of funds for contract research, and timely, submission of progress and financial accounting reports. Program images were tarnished, particularly in the eyes of farmers, the ultimate clients, at on-farm research sites.

- Improve monitoring and evaluation of ongoing research and strengthen the role of the Planning and Evaluation Division of BARC.

- Increase the number of microcomputers at the research stations to increase efficiency in research planning, data processing, and report writing.

- Include a sociologist within the team of specialists, at BARC, and at participating research institutes. A sociologist is necessary to handle the sociological, organizational, institutional issues and aspects of irrigation.

- Contract research needs careful administrative attention. There was inadequate literature search in submitted contract research proposals; irregular meetings of the technical committee responsible for review and approval; a lengthy process before funds were released to start approved research; further delays during preparatory activities, i.e., hiring of personnel, equipment purchases, etc., and a very high turn-over of contract research personnel.

- Increase the number of agricultural engineers at regional stations to do research instead of just maintaining equipment and farm machinery. There was no one in the extension department to help interpret research results or to facilitate technology transfer.

- Train supervisors to encourage researchers to process research data, write reports, and present results in seminars or publications in a timely manner.

- Provide suitable space to store equipment and funds for repairs and spare parts to increase the useful life of commodities.

Most of the researchers at the lowest and mid-level posts showed favorable attitudes conducive to professional development. There was difficulty in sustaining an intense desire to improve themselves and apply the skills and information gained in the field.

Task ahead: These will be presented under each of the 10 broad issues addressed by the program. The identification of the recommendations that follow were based on: i) the document "Priorities for Research in Irrigation and Water Management"; ii) the document "Status of Recommendations made by Consultants to the Irrigation and Water Management Program Area of ARP-II; and iii) IWM staff's perception of

important activities which should be addressed, but were not mentioned in the previous two documents or were not completely covered in ARP-II.

Groundwater. The opportunities for conjunctive use of surface and groundwater within large scale irrigation areas -- most notably the Ganges-Kobadak project -- should be given serious consideration by the Government of Bangladesh. Often the command areas remain fallow during the rabi season. An effort in this area would substantially augment agricultural production.

- A study to design wells, based on hydrogeological conditions and aquifer characteristics in particular areas of the country should be pursued. Design and specifications for screens, gravel pack, well development, pumpset, pumphouse, type standardized countrywide design currently in use.

- In order to obtain better estimates of available groundwater for irrigation, more research is needed on the physical factors affecting infiltration and percolation of clay material, with relatively low permeability.

- While current use of agricultural fertilizers and pesticides on crops is still relatively low there is a need to identify regions where possible background concentrations of contaminants exceed drinking water standards, or pose a danger to crops using groundwater for irrigation. "Risk" monitoring should be carried out for areas where iron and boron are high, and for those areas where some specialized crops such as tea, cotton, and potato, using high quantities of nitrogen and pesticides, pose potential groundwater quality hazards.

- A countrywide study on the role of groundwater vis-a-vis rainfed agriculture should have high priority. Enhancement of moisture in the soil profile through groundwater management has not been duly explored.

Water lifting devices. Establish actual pumping rates and efficiencies of "typical" areas and pump operations to determine better water capture.

- Conduct studies to assess the potential of liquid petroleum gas in powering irrigation pumps.

- Institute a forum to focus on issues and options concerning power (energy), and its relationship to irrigation should be considered. Likewise, a workshop addressing manual pumps (present and future) is urgently needed to provide some direction to future work in this particular field.

- Develop a far-reaching study on matching the well-pump-motor complex is long overdue. Present knowledge suggests there is a major constraint preventing efficient utilization of irrigation technology in the country.

Water distribution system. Monitoring and evaluation of technical, social, and organizational issues of improved distribution systems already in place throughout the country should be done. This should provide guidance to the government when formulating policies for future directions in irrigation development and in cost-sharing with beneficiaries.

- Determine the minimum number of appropriate type(s) of measuring and control devices, must be made. They must have minimum lengths for partial lining of open channel distribution subsystems, providing the maximum reduction in conveyance loss, the least erosion problems, and increase command area or reduce pumping costs.

- Apply a systems approach or operation research for optimizing techniques in developing/managing surface and(or) groundwater use in irrigation, drainage, and flood control projects.

- Monitor water quality of supply and surplus runoff water, including studies on the reuse of drainage water.

Irrigation of crops other than rice. Formulation of suitable designs for a drainage subsystem that can be integrated with an existing irrigation subsystem to increase the water available for crop diversification.

- Continue studies on crop response to water and irrigation-fertilizer interaction(s). Diversified crops grown in larger plots than those currently in use would reflect conditions in the farmers field more closely.

- Study ferti-gation and chemi-gation (fertilizer and chemicals introduced with irrigation water deliveries) in surface, sprinkler, and drip irrigation water application.

- Review feasibility for retrofitting irrigation systems designed and constructed primarily for rice irrigation to include diversified cropping.

- Demonstrate effective rainfall utilization in irrigated fields and residual moisture conservation in rainfed areas.

- Institute minimum and deep tillage practices to conserve soil moisture and improve infiltration/recharge of aquifer.

Irrigation of problem soils. Selection and development of salt-tolerant varieties of rice and rabi crops (including pastures and grasses) for the coastal belt should continue. The outcome of this effort should have an impact on water management activities in those areas.

- There is a need to delineate areas for crop production (traditional and nontraditional), and other uses (shrimp culture and salt harvesting) in the coastal areas, to establish an environmental setting from which the recommendation above can be pursued.

- We should study agronomic practices vis-a-vis water management in salt-affected areas. These studies should concentrate, but not be limited to, soil residual moisture handling, adoption of cropping patterns to brackish water salinity levels, and farmers adoption of nontraditional practices.

- Continue time-series monitoring of chemical-physical properties of the various water bodies in the coastal areas, as a basis to support water management strategies in the region.

Sociological and economic issues in irrigation. Socioeconomic studies of pond/minitank rehabilitation schemes for conjunctive use with irrigation as the primary or secondary purpose. This must include the desirability of utilizing landless groups to manage ponds with multiple owners.

- Pool surface and groundwater data with the sociopolitical-economic profile at the Upazilla level, to facilitate development planning and operations management.

- Establish surface and groundwater as well as meteorological data storage and retrieval systems to encourage public information sharing through radio, television, and press.

- Improve reliability of services to farms within the tertiary or rotation levels (by section of main canals, or by branch/lateral, etc.) gained by improvements in main canal subsystem operation and management. This may reduce the vicious "dog-chasing-its-tail" cycle affecting irrigaters' and water managers' relationships and performances.

- Develop mechanisms for water and cost-sharing arrangements and a method for resolving disputes among irrigaters in minor irrigation systems.

- Provide built-in funds for contract research that will allow partial or complete subsidy to irrigaters during initial stages of testing and(or) demonstrating improved irrigation water management practices.

- Hire a specialist with a sociological background to assist and interact with the engineers, soil specialists, agronomists, and economists dealing with irrigation and water management.

Research and extension linkages. A member from the Directorate of Agricultural Extension and Rural Development Board should be included in the technical review team at BARC. This would provide assurance that their needs, particularly in technology transfer, are considered.

- Establish a simple but functional hydrometeorological station at research stations and in areas within the responsibility of extension agents. This would allow them to practice, an irrigation management extension service before advising farmers about scheduling.

- Promote systematic and integrated operational planning and plan implementation. In provisioning water, seed, fertilizer, chemicals, labor, credit, and other services the plan should be primarily based on a cropping calendar predefined and acceptable to farmers.

- Integrate support studies by zone/district on processing and marketing needs, prior to expanding irrigated diversified crop production areas for export crops or for local consumption.

- Simplify predicting water requirement at farmer or extensionists' levels of competence based on locally available material. Research results obtained with sophisticated equipment/instruments, often cannot be transferred directly from the station to farms, unless adjusted to real field conditions.

Development of personnel and institutions. Establishment of a research, demonstration, and training ground for locating appropriate measurement and control devices as well as practicing improved irrigation and water management techniques at BARI and BRRI is needed for diversified crops and rice production, respectively.

- Encouraging a multidisciplinary team approach pooling together research results generated by engineers, soils scientists, agronomists, and economists to classify the suitability of land for irrigation (considering soils, topography, and drainage). This in turn will identify lands best suited to growing rice crops alone or diversified crops or cultivation of both.

- Assessing training needs as basis for development of a training program. A continuing assessment of the performances of individual personnel in the field should be pursued.

- Developing a "core" of mobile, permanent training staff working for a fixed period each year to conduct training of trainers, development of training manuals and teaching aids, and to evaluate ongoing professional development programs would improve long-term program performance.

- Establishing a waterlogging and salinity control laboratory and research station with capability of detecting possible man-induced chemical pollutants and the spread of naturally occurring toxic elements which may affect pumps, wells, etc.

Monitoring and evaluation of research projects. Monitoring and evaluation of research should be an integral part of the research process. During ARP-II this did not seem to be the case. A study to develop a monitoring and evaluation approach that fits the resources (funding and manpower) of the institutions, including the Council, seems appropriate.

Policy issues. Considerable effort on the part of the Government of Bangladesh in providing stronger links between research and development institutions is necessary. A study to identify the current strong and

weak aspects of this relationship can provide guidelines for future action.

- Study the long-term implications of current government water management related policies, e.g., privatization, shifts from diesel to electric operated irrigation equipment, equipment rental by landless groups and standarization of irrigation equipments.

- For irrigation and water management like all other agricultural research disciplines, the determination of research priorities is a must. This exercise needs to be formalized and conducted on a continuous basis probably every 2 years.

5.9 PEST MANAGEMENT RESEARCH

Good progress has been made in development of crop protection research and appropriate technology is now emerging for application in agricultural production. Notwithstanding the achievement under ARP-II, further activity will be required to develop the full potential of crop protection to sustain and enhance the achievements.

- There is no identifiable unit for coordination and appraisal of crop protection research. This has been effectively accomplished in several developing countries through creation of national crop protection centers. A similar approach is needed in Bangladesh. Consideration should be given to establishing such a center under the aegis of a unit at BARC headed by a director (in the crops division), or better still a member-director for a pest management division. This could provide a focus for planning, such as that achieved by the ad hoc committee for the crop protection plan, and to coordinate interinstitutional research and extension programs on toxicology, biological control, surveillance and monitoring, nematology, soil pathogens, vertebrates, etc., that are not single crop problems.

  Activity aimed at development of such a unit should be initiated with a team of expatriate and Bangladeshi experts drafting a proposal for funding.

- Provision of adequately trained staff for crop protection research continued as a major constraint to timely development of pest management technology. In-country degree training does not provide researchers with the breadth and depth of education needed to cope with challenges of developing new approaches to pest management. GOB should move rapidly to fill vacant position and funding should be sought for Ph.D. and M.Sc. degree training in the U.S.A. Graduate degree programs in the United States are more likely to address past deficiencies and future needs through continued course work in graduate degree programs.

  It is suggested that future programs should include training for a minimum of three Ph.D. and three M.Sc. in entomology (BARI) and a

like number in plant pathology with adequate funding for research projects developed prior to their return to Bangladesh.

Rapid change has occurred in crop protection research in recent years. Study/training tours (6-12 months) should be provided mid-career scientists to update their skills. A crucial element for this training is timely approval by the GOB so program activities can coincide with those of host institutions.

- Expatriate assistance was dominated by specialists with the broad mandate of developing general guidelines and programs for overall uplift of research capability. This was achieved. The need at this time is for problem specific expertise by short-term specialists to assist individual researchers on developing crop or pest specific programs. For example, time and spacial sequential sampling and threshold of damage in pulses, or rapid screening methods for host plant resistance to insects in cheena and kaon. These may be 3 to 6 month consultancies by active research counterparts at other institutions. Such consultancies should be funded to provide for specific items of equipment and assistants to implement research in Bangladesh, perhaps with local as well as foreign exchange funding.

While the position on equipment for research in the BARI divisions of entomology and plant pathology vastly improved, two categories remain deficient and deserve specified and immediate attention: a gas-liquid chromatography unit and accessory items is urgently needed in the insecticide toxicology laboratory at BARI and a recurring item identified in every appraisal and thus far ignored, is a 4-wheel vehicles for mobility in surveillance and off-station research work. The most desirable vehicles would be dual cab diesel pickup trucks to move personnel and equipment. There should be a specific item identification for one unit at each division at BARI headquarters and one (to be shared by entomology and plant pathology, exclusively) at each of the RARSs. Thus a total of seven would be required. Pest populations are dynamic and sporadic and require continual monitoring to properly assess their impact on crop production. This cannot be accomplished by public conveyance. Necessary equipment cannot be managed on bicycles and motorcycles.

A final item of future emphasis in the work program is related to on-farm research and farming systems research activities. At this time, there are no crop protection specialists assigned to this project to guide and monitor pest management activities. This must be corrected by provision of additional posts for entomologists and plant pathologists at the central coordinating unit and also at the research activity sites for this work exclusively. Proper management of pest technology could be the difference between success and failure of this activity. A preprogrammed scheduled approach is an intolerable substitute.

6. ACTIVITIES TABLES

Table 6.1. Specialists.

Name and program area	Total person-months per amendment	Total number of person-months for project	Balance of person-months
1. Research Systems Management			Minus
1.1 Project supervisor and administrator	72.5		2.25
1.1.1 Murray Dawson		19	
1.1.2 David M. Daugherty (with extension)		55.75	
1.2 Administrative Specialist	67.5		7
1.2.1 Raphael Semmes		20	
1.2.2 Edward Rosentel		29	
1.2.3 Robert Gustafson		11.50	
1.3 Program Assistant/Assistant Editor	18		1
Iris Gill		17	
2. Technical Support			
2.1 Farm Development Specialist	36		0
D. N. Sharma		36	
2.2 Maintenance Specialist	38		4
2.2.1 Harvey L. Carr		19.25	
2.2.2 L. R. Mattick (with extension)		14.75	
2.3 Training Specialist	36		0
Dorsey F. Davy		36	
2.4 Communication and Information Specialist	48		1
2.4.1 Theodore Hutchcroft		36	
2.4.2 Peter Thorpe (extension)		11	
3. Farming Systems Research			
3.1 Farming Systems Specialist	68		
Alejandro Hugo Manzano		57.75	5.75
Robert Hudgens		4.5	
3.2 Production Agronomist - Ishurdi	48		1
3.2.1 Robert Drew		12	
3.2.2 R. N. Mallick		35	
3.3 Production Agronomist - Jessore	60		0
Leopoldo Villegas		60	
3.4 Production Agronomist - Jamalpur	54.5		2.50
3.4.1 Timothy S. Kelly		27	
3.4.2 Nadarajah Vignarajah		25	
3.5 Production Agronomist - Hathazari	24		0
R. N. Mallick		24	
3.6 Production Agronomist - Joydebpur	26		0
Eduardo Perdon		26	
4. Crops Research			
4.1 Agronomy	24		1.5
Russell D. Frazier		22.5	
4.2 Crops	59		3
Avtar Kaul		51	
Carl Hittle		5	
4.3 Horticulture	42		4.50
4.3.1 Edward Loomis		22.5	
4.3.2 Deran Markarian		15	

Table 6.1. Specialists (continued).

Name and program area	Total person-month per amendment	Total number of months for project	Balance of person-months
5. Economics and Social Science			
5.1 Agricultural Economist	65		.5
Brook Greene		64.5	
6. Livestock Research			
6.1 Livestock Specialist	35		.5
6.1.1 Hugh E. Henderson		6	
6.1.2 James R. Dickey		28.5	
7. Soil Management			
7.1 Soil Fertility Specialist	55		1
Sam Portch		54	
8. Water Management			
8.1 Water Management Specialist	46		3
8.1.1 Jan J. Gerards		7	
8.1.2 R. D. Lazaro		36	
8.2 Water Management Extension Specialist	36		.75
David Gisselquist		35.25	
8.3 Agricultural Engineer	44.5		0
Carlos Garces		44.5	
9. Pest Management			
9.1 Plant Pathologist	24		1.25
Dale T. Krigsvoid		22.75	
9.2 Entomologist	36		Minus
Travis Everett		38.5	2.50
Total	1,063	1,029.50	33.50

Table 6.2. Expatriate consultants.
6.2.1. Research Systems Management

Name	Arrival date	Man-months	Consultancy Title	Remarks
1. Dr. R. L. Cushing	Feb. 20, 1982	1 month	To Develop the 5-year Master Plan of Action for Contract Research Phase II	
2. Dr. David James	Oct. 1, 1982	4 weeks	Evaluation of Contract Research	
3. Dr. L. F. Hesser	March 12, 1983	1 month	External Review Contract Research Program of the BARC	
4. Dr. D. W. Barton	March 12, 1983	1 month	" " "	
5. Mr. Loyd Johnson	March 12, 1983	1 month	" " "	
6. Mr. Gary Howe	March 20, 1983	11 days	Assess the Controls of Accounting Systems at Headquarters and in the Field	
7. Dr. Jock Anderson	May 1, 1983	1 month	BARC/IADS First External Evaluation ARP Phase II	
8. Dr. Kim Bridges	May 1, 1983	1 month	" " "	
9. Dr. Oleen Hess	May 1, 1983	1 month	" " "	
10. Dr. Carl Pray	May 1, 1983	1 month	" " "	
11. Dr. Alexander Daunys	July 29, 1983	6 weeks	Assist with Administrative and Financial Management	
12. Mr. Edward R[illegible]entel	Aug. 15, 1983	2 weeks	Administration and Financial Accounting	
13. Mr. Fernando Bernado	Aug. 21, 1983	6 weeks	Prepare National Agricultural Research Plan	
14. Dr. Donald Barton	Aug. 23, 1983	6 weeks	" " "	
15. Dr. Stephen Harsh	Nov. 9, 1983	9 days	To Evaluate BARC Computer Needs	
16. Dr. Guy Baird	July 15, 1984	2 months	To Review Terms of Reference for IADS Specialists	
17. Dr. Robert Callahan	Nov. 29, 1984	3 weeks	Agricultural Research Training Course	
18. Dr. Donald Spears	Nov. 28, 1984	3 weeks	" " "	

Table 6.2. Expatriate consultants (continued).
6.2.1. Research Systems Management

Name	Arrival date	Man-months	Consultancy Title	Remarks
19. Dr. Ronald Grosz	Jan. 8, 1985	4 weeks	Training Course on Diffusion of Agricultural Technology	In-country training
20. Mr. Donald Esslinger	Jan. 8, 1985	4 weeks	Training Course on Diffusion of Agricultural Technology	In-country training
21. Dr. Byron Mook	March 22, 1985	9 days	Workshop on Program for Planning and Evaluation	In-country training
22. Dr. Byron Mook	July 19, 1985	9 days	" " "	
23. Dr. Byron Mook	Oct. 13, 1985	1 week	" " "	
24. Dr. Fletcher Riggs	March 31, 1985	1 month	External Evaluation	
25. Dr. Reeshorn Feuer	March 31, 1985	1 month	" " "	
26. Dr. Maurice Peterson	March 31, 1985	3 1/2 weeks	" " "	
27. Dr. Kay Calavan	April 1, 1985	6 1/2 weeks	" " "	
28. Dr. Ludwig Eisgruber	April 14, 1985	2 weeks	Review of the Curricula of IPSA	
29. Dr. J. M. Poehlman	April 19, 1985	4 weeks	Review of Research Plan and Objective Jute Research Institute	
30. Dr. Fletcher Riggs	May 1, 1985	13 days	External Evaluation	
31. Dr. Guy Baird	Aug. 16, 1985	6 weeks	Review of the Planning and Evaluation Cell of BARC	
32. Mrs. Kirsten Gibney	July 5, 1986	5 weeks	Program Assistant	
33. Mrs. Eva Eisgruber	July 22, 1986	10 1/2 months	Computer Consultant	In-country training
34. Mrs. Ann Mather	Aug. 27, 1986	9 months	Program Assistant	

Table 6.2. Expatriate consultants.
6.2.2. Maintenance

Name	Arrival date	Man-months	Consultancy Title	Remarks
1. Dr. Leonard Mattick	Oct. 15, 1985	2	Analyze equipment; repair and maintenance	
2. Mr. Harvey Carr	March 13, 1987	3	Farm machinery; maintenance and repair	

Table 6.2. Expatriate consultants.
6.2.3. Technical Support Systems
6.2.3.1. Training

Name	Arrival date	Man-months	Consultancy Title	Remarks
1. Dr. Francis C. Byrnes	Nov. 11, 1983	2 weeks	To assist in setting up training procedures and a plan to effectually utilize short-term training funds under the project	
2. Dr. James E. Haldeman	Jan. 12, 1984	12 days	International training activities	
3. Mr. Alan H. Thomas	Jan 12, 1985	6 months	Training Consultant	

Table 6.2. Expatriate consultants.
6.2.3. Technical Support Systems
6.2.3.2. Agricultural Information

Name	Arrival date	Man-months	Consultancy Title	Remarks
1. Mr. Steven Breth	July 16, 1982	2 weeks	Assist in reprinting "This is BARC" and prepare plans for the BARC publication and information units	
2. Mr. Seth Beckerman	Feb. 14, 1985	2 weeks	Workshop for Researchers on the Public Presentation of Scientific Information	In-country training 1/2 course completed
3. Ms. Anito DeVivo	June 7, 1985	1 month	Workshop for Editors of Agricultural Science Journals	
4. Mr. Anthony Woodward	July 12, 1985	1 month	To design and implement a system for computerization of the national agricultural research system	
5. Dr. Mervin George	Dec. 3, 1985	3 weeks	Library development and acquisition for IPSA/BARC	
6. Mr. Anthony Woodward	May 27, 1986	8 weeks	Computerization of NALDOC, BARC Bangladesh	In-country training
7. Ms. Melissa Beck Yazman	Nov. 5, 1986	1 week	Orientation to video camera and preparation of research and training VTR films	In-country training
8. Mr. Steven Breth	Jan. 16, 1987	2 weeks	To write, edit, and arrange printing of a new edition of "This is BARC"	
9. Ms. Melissa Beck Yazman	Feb. 2, 1987	4 weeks	Video Production Training workshop	In-country training
10. Dr. James Bemis	Feb. 27, 1987	May 15, 1987	Communications at BARI	

Table 6.2. Expatriate consultants.
6.2.4. Economics and Social Science

Name	Arrival date	Man-months	Consultancy Title	Remarks
1. Dr. Randy Barker	Aug. 29, 1982	1 week	Program in agricultural economics at BARC	
2. Dr. Ben Wallace	Jan. 1, 1983	6 months	Preliminary investigation of the social and cultural factors conditioning agriculture in rural Bangladesh	
3. Dr. Stanley C. Pearce	Jan. 16, 1984	1 month	Two shortcourses in Agricultural Statistics in Bangladesh	In-country training
4. Mr. G. Vaughan Dyke	Jan. 16, 1984	1 month	" " "	
5. Dr. Robert Kempson	Jan. 16, 1984	1 month	" " "	
6. Dr. Kee Chai Chong	Feb. 24, 1984	2 weeks	Workshop on Aquacultural Economics	
7. Dr. Wilfrido D. Cruz	Feb. 24, 1984	2 weeks	" " "	
8. Dr. Theodore Panayotou	March 4, 1984	2 days	" " "	
9. Dr. Ben Wallace	Jan. 3, 1984	2 weeks	Develop long-term research for agricultural economics at BARC	
10. Dr. R. V. Kemper	Jan. 3, 1984	2 weeks	" " "	
11. Dr. Ben Wallace	May 22, 1984	2 months	Socioanthropological research relating to Bangladesh agriculture	
12. Dr. R. V. Kemper	May 22, 1984	2 months	" " "	
13. Dr. Larry Nelson	July 29, 1984	1 month	Agricultural applied statistics	
14. Mr. A. N. Choksi	Sept. 1, 1984	4 months	To assist BARC in strengthening its database and capability in agricultural credit	
15. Mr. A. N. Choksi	May 1, 1985	3 months	" " "	
16. Dr. Ben Wallace	Jan. 1, 1985	2 1/2 weeks	The Role of Women in Farming Systems	

Table 6.2. Expatriate consultants (continued).
6.2.4. Economics and Social Science

Name	Arrival date	Man-months	Consultancy Title	Remarks
17. Dr. Richard R. Howes	Feb. 11, 1985	1 month	To develop policy oriented model of the irrigation sector under water management program	
18. Dr. Robert E. Kempson	March 21, 1985	1 month	Prepare and present a shortcourse in use of multiple regression techniques in socioeconomic research	
19. Mr. Alison M. Burrell	April 4, 1985	2 weeks	" " "	
20. Dr. Sam Johnson III	Feb. 5, 1984	7 weeks	Water Management Economics Program	
21. Mr. Donn F. Davy	April 1, 1985	6 weeks	Computer training	In-country training
22. Dr. Douglas Neeley	April 14, 1985	1 month	Short-term training survey and sampling methodology	In-country training
23. Dr. Ben J. Wallace	May 24, 1985	2 months	Role of Women in Household Income	
24. Dr. R. V. Kemper	May 24, 1985	2 months	" " "	
25. Ms. Margot Wilson Moore	May 24, 1985	2 months	" " "	
26. Dr. Michael S. Harris	May 29, 1985	11 weeks	Computer Programmer/data analyst	
27. Dr. K. Mershrod	July 31, 1985	1 month	The BARC MSTAT Course	
28. Dr. Pradam Prasad Sharma	Jan. 1, 1986	2 weeks	" " "	
29. Dr. Ben Wallace	Jan. 1, 1986	2 weeks	The Role of Women in Household Income	
30. Dr. R. V. Kemper	Jan. 1, 1986	2 weeks	Dynamics of Rural-urban Migration	
31. Dr. Ben Wallace	May 23, 1986	1 month	Role of Women in Household Income	
32. Dr. R. V. Kemper	June 3, 1986	1 month	Rural Urban Dynamics	
33. Ms. Margot Wilson Moore	May 23, 1986	1 month	Role of Women in Household Income	
34. Ms. Margot Wilson Moore	Jan. 6, 1987	4 months	Household Socioeconomic Activities Project	

Table 6.2. Expatriate consultants.
6.2.5. Crops Research
6.2.5.1. Agronomy and Crops

Name	Arrival date	Man-months	Consultancy Title	Remarks
1. Dr. Joseph Hunt	Dec. 1, 1983	13 months	Food policy analyst for BARC	
2. Dr. Jagdish Kumar	Jan. 17, 1984	2-1/2 weeks	Examine research programs in chickpea, pigeon pea, and lentils; also examine BARC Coordinated National Pulses Improvement Program	
3. Dr. Jagdish Kumar	July 4, 1984	11 months	Pulses consultant at BARI	
4. Dr. Rajat De	Jan. 21, 1985	4 months	Agronomy and soil fertility management for rainfed/dry land agriculture	
5. Dr. L. J. Reddy	July 2, 1985	1 year	Groundnut breeding	
6. Dr. Rajat De	June 8, 1986	1 year	Rainfed agronomy	
7. Dr. Thomas G. Hart	Sept. 12, 1986	3 months	Maize research and development planning	
8. Dr. Kishan Singh	March 1, 1987	6 weeks	a) Sugarcane pathology nematology and breeding b) Prepare 10-year master plan	
9. Dr. A. Kumar Shosh	March 10, 1987	4 weeks	Weed management research review and planning	

Table 6.2. Expatriate consultants.
6.2.5. Crops Research
6.2.5.2. Horticulture

Name	Arrival date	Man-months	Consultancy Title	Remarks
1. Dr. Andrew A. Duncan	Jan. 4, 1984	2 weeks	Horticulture course development	
2. Dr. Andrew A. Duncan	June 11, 1985	1 week	Horticulture SMS courses	
3. Dr. Claylon R. Oslund	June 21, 1985	1 month	" " "	
4. Dr. Walter Lewis	June 21, 1985	4 weeks	" " "	
5. Dr. Jack Gershon	Sept. 27, 1985	2-1/2 weeks	Development of homestead garden production (kitchen gardens)	

Table 6.2. Expatriate consultants.
6.2.6. Livestock Research

Name	Arrival date	Man-months	Consultancy Title	Remarks
1. Dr. T. R. Preston	Feb. 7, 1983	1 month	Develop an Integrated Crop/Livestock/Fish Plan for BARI at Joydebpur	
2. Dr. George Wellington	Feb. 1, 1985	7 weeks	The present status of livestock research	
3. Mr. F. M. Moog	March 28, 1985	2-1/2 weeks	Feed and Fodder Training Program	
4. Dr. D. V. R. Rangneker	March 28, 1985	2-1/2 weeks	" " "	
5. Dr. Leopoldo Castillo	May 9, 1985	2 weeks	Course on Cattle and Buffalo Production	
6. Dr. Charan Chantalakhana	May 9, 1985	2 weeks	" " "	
7. Dr. Robert Temple	Dec. 1, 1985	11 days	Workshop on Livestock and Poultry Research and Methodology	In-country training
8. Dr. Charan Chantalakhana	Dec. 13, 1985	12 days	" " "	

Table 6.2. Expatriate consultants.
6.2.7. Soil Management

Name	Arrival date	Man-months	Consultancy Title	Remarks
1. Dr. Sam Portch	July 9, 1982	2 weeks	Soil Fertility Program in Bangladesh	
2. Mr. Ronald Clayton	March 4, 1983	4 weeks	Laboratory Repair Maintenance	
3. Dr. James W. Fitts	March 25, 1983	3 weeks	Evaluate the Soil Program Proposals and Philosophies and Make Recommendations for Improvement	
4. Dr. Larry Sanders	Jan. 29, 1984	2 weeks	Soil Fertility and Fertilizer Use	
5. Dr. Robert L. Blevins	Jan. 30, 1984	2 weeks	Minimum Tillage Specialist	
6. Dr. Douglas P. Beck	March 6, 1984	2 weeks	Biological Nitrogen Fixation Course	In-country training
7. Dr. H. Douglas Gross	March 7, 1984	2 weeks	" " "	
8. Dr. Robert J. Davis	March 9, 1984	2 weeks	" " "	
9. Dr. Leonard Mattick	May 17, 1984	1 month	Instrumentation Equipment Repair and Maintenance	
10. Dr. Arvel Hunter	Jan. 11, 1985	3 weeks	Soil Fertility Analytical Services	
11. Dr. Larry Sanders	Feb. 19, 1985	3 weeks	Soil Fertility and Fertilizer Use	In-country training
12. Dr. Robert T. Davis	Feb. 26, 1985 April 23, 1985	1 month	Biological Nitrogen Fixation	
13. Dr. Leonard Mattick	March 8, 1985	5 weeks	Course in Analtyical Equipment and Instrumentation	
14. Dr. Lloyd H. Murdock	March 10, 1985	2 weeks	Minimum Tillage Research	
15. Dr. Joe L. White	April 16, 1985	2 weeks	Soil Minerology	
16. Dr. Arvel H. Hunter	Jan. 10, 1986	4 weeks	Soil Fertility	
17. Dr. Nantakorn Boonkerd	Feb. 14, 1986	1 week	Biological Nitrogen Fixation	In-country training
18. Dr. Larry Sanders	March 2, 1986	2 weeks	Soil Fertility	" "

Table 6.2. Expatriate consultants (continued).
6.2.7. Soil Management

Name	Arrival date	Man-months	Consultancy Title	Remarks
19. Dr. S. S. Prihar	Jan. 27, 1987	3 months	Physical Aspects of Soil Management	
20. Dr. Larry Sanders	Feb. 1, 1987	3 weeks	Soil Fertility and Fertilizer Use	In-country training
21. Dr. Nantakorn Boonkerd	Feb. 6, 1987	2 weeks	Biological Nitrogen Fixation	" "
22. Dr. James Box	March 20, 1987	3 weeks	Soil Conservation Research Methodology	

Table 6.2. Expatriate consultants.
6.2.8. Irrigation and Water Management

Name	Arrival date	Man-months	Consultancy Title	Remarks
1. Dr. David Gisselquist	Sept. 30, 1982	2-1/2 weeks	Water Management Extension Specialist Activities	
2. Dr. Loyd Johnson	Nov. 5, 1982	5 weeks	Agricultural Engineering Activities under ARP-II	
3. Dr. Loyd Johnson	March 1, 1983	1 month	Water Management Issues in Bangladesh	
4. Dr. Gil Levine	Aug. 5, 1983	1 month	Water Management Workshop	
5. Dr. George Radosevitch	Sept. 11, 1983	1 month	Legal Aspects of Water Use in Bangladesh	
6. Dr. Florence E. McCarthy	Sept. 13, 1983	1 month	Irrigation Water Management Program at Bangladesh	
7. Dr. Ramchand Oad	Sept. 16, 1983	1 month	" " "	
8. Dr. Duane Johnson	Sept. 16, 1983	1 month	" " "	
9. Dr. Michael F. Walter	Sept. 17, 1983	1 month	" " "	
10. Dr. Richard Howes	Oct. 25, 1983	2 months	Power Use in Irrigation	
11. Dr. T. F. Weaver	Jan. 8, 1984	2 weeks	Organization and Irrigation Policy in Bangladesh	
12. Dr. M. Rosegrant	Jan. 8, 1984	2 weeks	" " "	
13. Dr. J. Romasset	Jan. 8, 1984	2 weeks	" " "	
14. Dr. J. Kellar	Jan. 8, 1984	2 weeks	" " "	
15. Dr. Sam Johnson III	Feb. 5, 1984	6 weeks	Economics of Deep Tubewell Irrigation	
16. Dr. Jan Emmert	July 10, 1984	3 weeks	Impact of Irrigation on Distribution of Benefits	
17. Dr. Donald Slack	July 6, 1984	3 weeks	External Evaluation of Irrigation Water Management Program Area	
18. Dr. Richard McConen	July 18, 1984	6 weeks	" " "	
19. Dr. Sam Johnson III	March 25, 1985	1 month	Development of Criteria to Determine Optional Mix of STWs and DTWs	

Table 6.2. Expatriate consultants (continued).
6.2.8. Irrigation and Water Management

Name	Arrival date	Man-months	Consultancy Title	Remarks
20. Dr. George Hargreaves	Feb. 14, 1985	1 week	Preliminary visit to set up Training Course	
21. Dr. Marvin Jensen	Feb. 24, 1985	1 week	Artificial Ground Water Recharge in Bangladesh	
22. Dr. Ghulum Sandhu	March 15, 1985	9 weeks	Saline Soils	
23. Dr. George Hargreaves	March 31, 1985	1 week	Irrigation Water Production Functions	In-country training
24. Mr. Leroy Salazar	March 20, 1985	2-1/2 weeks	" " "	
25. Dr. David James	March 26, 1985	1-1/2 weeks	" " "	
26. Dr. Calvin Clyde	March 31, 1985	4 weeks	Ground Water Investigations	In-country training
27. Mr. Tim Decker	March 31, 1985	4 weeks	" " "	
28. Ms. Jane Johnson	April 2, 1985	3-1/2 weeks	Preliminary visit to set up Training Course	
29. Mr. Jim Logan	April 13, 1985	2-1/2 weeks	" " "	
30. Dr. John Replogle	April 19, 1985	1 month	Measuring and Control Devices for Small-Scale Irrigation Systems in Bangladesh	
31. Dr. Brij M. Sahni	April 21, 1985	5 weeks	Well Technology	
32. Ms. Jane Johnson	April 25, 1985	3 weeks	Development of Computerized File on Library Holdings in Irrigation and Water Management	
33. Dr. Horato L. Angeles	May 7, 1985	6 weeks	Irrigation Methods for Upland Crops	

Table 6.2. Expatriate consultants (continued).
6.2.8. Irrigation and Water Management

Name	Arrival date	Man-months	Consultancy Title	Remarks
34. Mr. Kevin Dalstead	July 2, 1985	1 month	Remote Sensing	In-country training; 2 courses
35. Mr. Robert G. Best	July 2, 1985	2-1/2 weeks	" " "	" "
36. Ms. Mary E. Devries	July 16, 1985	10 days	" " "	" "
37. Mr. Victor Myers	July 21, 1985	1 week	" " "	" "
38. Dr. William Carson	Nov. 5, 1985	11 weeks	Design of Irrigation and Drainage System at BARI Substation at Debiganj, Dinajpur	
39. Dr. Frederick C. Westin	July 23, 1985	10 days	" " "	In-country training
40. Dr. John Replogle	Nov. 6, 1985	1 month	Measuring and Control Devices for Small-Scale Irrigation System in Bangladesh	
41. Dr. J. F. Wymore	Jan. 14, 1986	8 weeks	Irrigation Scheduling	
42. Dr. A. M. Michael	Feb. 19, 1986	5 weeks	Conjuntive Use of Surface and Groundwater	
43. Dr. Calvin Clyde	March 16, 1986	4 weeks	Groundwater Investigation	In-country training
44. Mr. Tim Decker	March 18, 1986	4 weeks	" " "	" "
45. Dr. Jim Labadie	May 18, 1986	2 weeks	" " "	
46. Dr. Tammo Steehuis	Jan. 13, 1987	6-1/2 weeks	Assessment of Groundwater Quality	
47. Dr. Michael Walter	Jan. 10, 1987	7 weeks	Role of Minitanks/Rain Water Harvesting	
48. Dr. Calvin Clyde	Jan. 10, 1987	1 month	Groundwater Investigations	In-country training
49. Mr. Tim Decker	Jan. 10, 1987	1 month	" " "	" "
50. Dr. A. M. Michael	Feb. 8, 1987	1 month	Assessment of Research and Pilot Demonstration on Water Distribution Systems and Crop-Water Requirements	

Table 6.2. Expatriate consultants.
6.2.9. Pest Management

Name	Arrival date	Man-months	Consultancy Title	Remarks
1. Dr. Edwin D. Magallona	Sept. 17, 1984	6 weeks	Consultant on Toxicology for Entomology Division at BARI	
2. Dr. Edward Glass	Jan. 8, 1985	3 weeks	Integrated Pest Management Course	Training Course
3. Dr. H. David Thurston	Jan. 13, 1985	2-1/2 weeks	" " "	Plant Pathology
4. Mr. Lynwood Fielder	Jan. 11, 1985	2 weeks	" " "	Vertebrate Pest
5. Dr. Robert A. Van Steenwyk	Feb. 1, 1985	4 weeks	Entomology Research Programming Design and Evaluation	
6. Dr. Charles Cole	April 1, 1985	6 weeks	Pest Surveillance and Monitoring	
7. Dr. Wendell Horne	April 9, 1985	5 weeks	" " "	Plant Pathology
8. Dr. Marvin Harris	April 1, 1985	6-1/2 weeks	Integrated Pest Management	
9. Dr. Marvin Harris	Nov. 8, 1985	3 weeks	Crop Protection Research Planning	
10. Dr. Edwin D. Magallona	April 15, 1986	2 months	Pesticide Toxicology	
11. Alice Woods				

6.3. Research Assistants.

Name	Consultancy	Year/duration
1. Dr. Hamidur Rahman	Evaluation of Contract Research Project	March 11 - April 10, 1983 (1 month)
2. Dr. A. Alim	" " "	" "
3. Mr. A. Jabbar	" " "	" "
4. Mr. Sumid Kumar Shaha	Data Processing	Sept. 1983 - June 1984 (10 months)
5. Mr. Shamsul Chowdhury	Store Management Development of Skills of Stores	December 1983 - February 1984 (3 months)
6. Dr. Amjad Hussain	Manpower Survey	April 1984 (2 months)
7. Mr. Musharaf Hossain	Annotated Bibliography and Library Acquisitions Program for BARC IWM Program	April 7, 1984 - November 30, 1985 (28 months)
8. Dr. A. K. M. Altaf Hossain Junior Consultant	" " "	July 15, 1984 (3 months)
9. Mr. Sardar Rustom	" " "	May - October 1985 (2-1/2 months)
10. Mr. Mohammad Azharul Haque	" " "	August 1 - October 30, 1985 (3 months)
11. Ms. Donna Jo Bale Foote Proofreader	Proofread Bibliography above	Appoximately 40 hours
12. Dr. Mozammel Hussain	Irrigation Economics	August 22 - December 21, 1984 (4 months)
13. Mr. A. T. M. Mooeen-ui-Alam	Inventory of all Farm Equipment	November 15, 1984 - February 15, 1985 (3 months)
14. Mr. A. B. M. Fazie Wahed	A Pilot Survey on Draft Power Requirements Availability and Utilization in Agricultural and Irrigated and Rainfed Conditions	November 15, 1984 - September 30, 1985 (10-1/2 months)
15. Mr. M. R. Talukder	Computer	December 1, 1984 - May 31, 1987 (2-1/2 years)
16. Dr. Nawajesh Ahmed	Translator of Agricultural Research in Bangladesh and production of a Bengali and English slide and sound program on the Agricultural Research System/Process in Bangladesh	1984-1985 (2/3 months)

6.3. Research Assistants (continued).

Name	Consultancy	Year/duration
17. Prof. M. Safiur Rahman	Livestock	February 2-20, 1985 (18 days)
18. Dr. Nurul Alam	Consolidation of Contract Research Documents	February 4 - March 3, 1985 (2 months)
19. Mr. Musharraf Hossain	" " "	2 months
20. Dr.Arshad Ali	Internal Evaluation of the Water Management Component	April 1-30, 1985 (1 month)
21. Mr. M. A. Moniz	External Evaluation of ARP-II	April 1-30, 1985 (1 month)
22. Mr. Wahed Khan	" " "	" "
23. Dr. Arshad Ali	" " "	" "
24. Prof. Mainui Hossain	Internal Evaluation of ARP-II	April 20-May 20, 1986 (1 month)
25. Mr. S. Ghoshal	" " "	" "
26. Mr. Mansur Ahmed Sarker	" " "	" "
27. Mr. S. A. Wahed A. T.	" " "	" "
28. Dr. Monirul Haque	" " "	" "
29. Mr. M. A. Quddus	" " "	" "
30. Dr. K. T. Hossain	" " "	" "
31. Mr. Hafizuddin Ahmed	" " "	" "
32. Prof. Akbar Hossain	" " "	" "
33. Mr. J. Talukder	" " "	" "
34. Dr. M. K. Khan	" " "	" "
35. Dr. Ruhul Amin	Internal Evaluation of ARP-II	April 20-May 20, 1986 (1 month)
36. Mr. Ahmed Hussain	" " "	" "
37. Dr. A. K. M. Moniruzzaman	" " "	" "
38. Dr. Kamal Uddin Ahmed	" " "	" "
39. Dr. J. Kassan	" " "	" "
40. Dr. Kh. Azharul Haq	" " "	" "

6.3. Research Assistants (continued).

Name	Consultancy	Year/duration
41. Mr. M. A. Quddus	" " "	" "
42. Dr. M. A. Jalil	" " "	" "
43. Dr. M. S. U. Chowdhury	" " "	" "
44. Dr. Ekramul Ahsan	" " "	" "
45. Mr. Sufta Ahmed	" " "	" "
46. Mr. M. A. Momen	" " "	" "
47. Miss. Shahriat Huda	Manpower Master Training Plan of the BARC Training Cell	July 21, 1986 - May 31, 1987 (10 months)
48. Miss. Sayeeda Sultana	" " "	" "
49. Dr. Monawar Akmed	External Evaluation 1987	March 7 - May 5, 1987 (3 months)
50. Dr. Munshi Siddique Ahmed	" " "	April 1 - May 5, 1987 (1 month)

6.4. Overseas Training.
6.4.1. Ph.D.

Name	Field of study	University	Date of arrival and departure
1. Kazi Murtuza Kabir	Plant Breeding	North Dakota State	August 1983 - August 1987
2. Quayum Parvez	Agronomy	Florida	August 1983 - August 1987
3. Ch. Md. Amiruddin Khan	Water Management	Colorado State	August 1983 - August 1987
4. Mufakharul Islam	Econ./Stat.	Purdue	January 1984 - December 1988
5. Muslem Uddin Mia	Soil Science	UPLB, Philippines	May 1983 - May 1987
6. Abdur Razzaque	Agronomy, FSR	UPLB, Philippines	May 1983 - May 1987
7. S. Salahuddin Kibria	Animal Science	UPLB, Philippines	May 1983 - May 1987
8. Ashraf Khan*	Plant Pathology	UPLB, Philippines	May 1983 - December 1988
9. R. Bhuiyan**	Agronomy	Louisiana State	January 1982 - January 1983

* Started as M.Sc. doing Ph.D. at own expense payment stopped November 1986.
**Funding provided for only 1 year of Ph.D. program.

6.4. Overseas Training.
6.4.2. M.S.

Name	Field of study	University	Date of arrival and departure
1. Parvin Sultana	Pest Management	Colorado State	March 1983 - August 1985
2. A. J. M. Sirajul Karim	Soil Science	Colorado State	August 1983 - February 1986
3. Rafiqui Islam Mondal	Agronomy	Cornell	August 1983 - February 1986
4. Monomohan Biswas	Horticulture	Hawaii	August 1983 - February 1986
5. Harun-ur-Rashid	Research Management	Cornell	August 1983 - February 1986
6. Shahabuddin Khan	Soil Science	Fresno State, California	August 1984 - February 1987
7. Joynai Abedin	Ag. Economics	UPLB, Philippines	April 1983 - October 1985
8. Tajul Islam	Agronomy, FSR	UPLB, Philippines	May 1983 - October 1985
9. Ashraf Khan	Plant Pathology	UPLB, Philippines	May 1983 - October 1985
10. Liakat Ali	Plant Breeding	CLSU, Philippines	May 1983 - October 1985
11. Azizur Rahman	Agronomy	CLSU, Philippines	May 1983 - October 1985
12. Sabjal Uddin	Agronomy	CLSU, Philippines	November 1983 - May 1985
13. Abdul Aziz Palwan	Water Management Ext.	CLSU, Philippines	November 1983 - May 1985
14. Wais Kabir	Irrigation	AIT, Thailand	January 1984 - June 1986
15. S. M. Nazimuddin	Irrigation	AIT, Thailand	January 1984 - December 1986 Returned Dec. 1984 with Diploma
16. Bazlur Rahman Khan	Farm Machinery	AIT, Thailand	January 1984 - June 1986
17. Kazi Mesbahul Alam	Ag. Economics	UPLB, Philippines	April 1984 - September 1986
18. Mustafizur Rahman Khan	Agronomy	UPLB, Philippines	May 1984 - December 1986
19. Nazrul Islam	Ag. Economics	CLSU, Philippines	May 1984 - December 1986
20. Nazrul Islam	Ag. Economics	CLSU, Philippines	June 1984 - December 1986
21. Rafiqul Islam	Ag. Economics	CLSU, Philippines	June 1984 - December 1986
22. Habibur Rahman	Farm Machinery	UPLB, Philippines	June 1984 - December 1986

6.4. Overseas Training.
6.4.3. Short-term Training

SL. No. and Name	Place of employment	Title of course	Duration	Location
1982-1983				
1. Abdus S. Taluker	BARC	Training of Trainers	2 months	Washington, D.C., U.S.A.
2. Monin Rahman	BARI	Water Management	6 weeks	Colorado State, U.S.A.
3. Mazharul Islam	BRDB	Soil and Irrigation	8 weeks	" "
4. W. I. Afzal Hossain	BAU	Poultry Disease	6 months	Texas, U.S.A.
5. M. T. Somobayee	BRRI	Farm Systems Research	6 months	Cornell, U.S.A.
6. Fazlul Hoque	BARI	Farm Systems Research	6 months	" "
7. Dr. Iajuddin Ahmed	DU	Water Management	6 months	" "
8. Dr. Z. Karim	BARI	Water Management	15 days	" "
9. Dr. Idris	BAU	Water Management	15 days	" "
10. D. M. A. Khan	BAU	Water Management	15 days	" "
11. Ismail Hossain	BARI	Water Management	15 days	" "
12. Bazlul Karim	BARD	Water Management	15 days	" "
13. Dr. Altaf Hussain	BARD	Research Plan and Analysis	10 days	" "
14. Shah Ahmed Ali Khan	BWDB	Irrigation & Water Management	10 weeks	IRRI, Philippines
15. Jalaluddin Ahmed	BAU	Cropping Systems Research	10 weeks	" "
16. Nurul Alam	BARI	Cropping Systems Research	10 weeks	" "
17. Nowsher Ali Sardar	BARI	Cropping Systems Research	10 weeks	" "
18. Ferdous Azad	BWDB	Cropping Systems Research	10 weeks	" "
19. Dr. M.S.U. Chowdhury	BARC	Research Management	6 weeks	A.I.M. Philippines
20. S. M. Rahman	INA	Water Management	10 weeks	Sri Lanka
21. Abdul M. Miah	BAU	Training of Trainers	2 months	Washington, D.C., U.S.A.
1983-1984				
22. Abdur Rashid	BARI	Vegetable Production	4 months	Kasetsart Univ., Thailand
23. Dhiduzzaman	BARI	Fertilizer Efficiency	20 days	Sovrooung, Malaysia
24. Shafiul Alam	BARI	Farm Service	5 months	ICRISAT, India
25. Hazrat Ali	BAU	Management of Agricultural Research	3 weeks	Swaziland

6.4. Overseas Training (continued).
6.4.3. Short-term Training

SL. No. and Name	Place of employment	Title of course	Duration	Location
26. Abu N. M. Ahia	BARI	Management of Agricultural Research	1.6 months	Washington, D.C., U.S.A.
27. Ziauddin Ahmed	BAU	Conservation Research	3.4 months	Kimberly, Idaho, U.S.A.
28. Kazi M. Ahmed	BARI	Crop Loss Assessment	0.9 months	Minnesota, U.S.A.
29. Mesbauddin Ahmed	BAU	Water Management	1.6 months	Colorado, U.S.A.
30. Dr. Jdris Ali	BINA	Visited Soil and Plant Labs	2.5 months	Hiwaii, Arkansas, Kentucky, New York, California, Alabama, U.S.A.
31. S. M. Ruhul Amin	BARC	Proj. Implementation for Ag. and Rural Development	1.5 months	Washington, D.C., U.S.A.
32. Dr. Idris Azim	BARC	Crop Loss Assessment	1.0 month	Minnesota, U.S.A.
33. Ms. Nazma Begum	BARC	Proj. Implementation for Ag. and Rural Development	1.5 months	Washington, D.C., U.S.A.
34. Mrs. Selina Begum	BARC	Women in Development	1.5 months	" "
35. Nural Bhuiyan	BAU	Entomology Research	3.6 months	Beltsville, MD, U.S.A.
36. F. A. Chowdhury	BAU	Visited Plant and Soil Labs	2.5 months	Hiwaii, Arkansas, Kentucky, New York, California, Alabama, U.S.A.
37. A. K. M. Enayettulluh	BARC	Management of Rural Development Programs	2.1 months	Washington, D.C., U.S.A.
38. Altaf Hossain	BARC	Management of Research Organizations	1.6 months	" "
39. Altaf Hossain	BARC	Proj. Planning and Analysis	2.4 months	" "
40. S. Islam	BARI	Visited Plant and Soil Labs	2.5 months	Hiwaii, Arkansas, Kentucky, New York, California, Alabama, U.S.A.
41. Mafizal Khan	BARC	Management of Ag. Research Facilities and Organization	1.6 months	Washington, D.C., U.S.A.
42. Mahbubur Rahman	BARI	Farming Systems Research	1.7 months	Cornell, NY, U.S.A.
43. K. Majlis	BJRI	Visited Plant and Soil Labs	2.5 months	Hiwaii, Arkansas, Kentucky, New York, California, Alabama, U.S.A.
44. Abul Khairaf Majumder	BAU	Soil Testing & Fert. Mgmt.	1.7 months	Alabama, U.S.A.
45. M. A. Malek	BARI	Cotton Research	6.1 months	Texas, U.S.A.

6.4. Overseas Training (continued).
6.4.3. Short-term Training

SL. No. and Name	Place of employment	Title of course	Duration	Location
46. A. J. Miah	BAU	Management of Ag. Research Facilities and Organization	1.6 months	Washington, D.C., U.S.A.
47. Yeasin Miah	BARI	Adm. of Ag. Research and Extension Linkages	1.9 months	Cornell, New York, U.S.A.
48. Dr. S. K. Paul	BARC	Management of Ag. Research Facilities and Organization	1.6 months	Washington, D.C., U.S.A.
49. Majibar Rahman	BARI	Farming Systems Research	1.7 months	Cornell, New York, U.S.A.
50. Ms. Sultana Razia	BARI	Specially Designed Training	5.5 months	" "
51. Kazi Abu Sayed	BAU	Math Refresher	3.1 months	Texas A&M, U.S.A.
52. Abdus Siddique	BARC	Adm. of Ag. Research and Extension Linkages	1.9 months	Cornell, New York, U.S.A.
53. Dr. Lutfur Rahman		Agricultural Economics	2 weeks	Ithaca, New York
54. Enayet Ullah		Water Management	3 weeks	Washington, D.C., U.S.A.
55. Mojur Hamid	BARI	Vegetable Production for Research & Extension Workers	3 months	Kasetsart Univ., Thailand
56. Amjad Hussain	BARI	" " "	5 months	" "
57. Molay Chandra Saha	BARI	" " "	5 months	" "
58. Asit Kumar Barker	BARI	" " "	5 months	" "
59. Ms. Wasefa Akhtar	BARI	Farming Systems Socio-economic Research	2 months	IRRI, Philippines
60. Rezaul Karim	BARI	" " "	2 months	" "
61. Nurum Nabi		" " "	2 months	" "
62. Dr. Mosharraf Hossain	BAU	Regional International Workshop on Ecotaxonomy	3-1/2 weeks	St. Johne College, Agra, India
63. Nuruilah	BAU	" " "	3-1/2 weeks	" "
64. Dr. Rosie Ahsan	DU	Role of Rural Women in Agriculture	1 month	SMU, Dallas, Texas
65. Shahman Hussain	DU	" " "	1 month	" "

6.4. Overseas Training (continued).
6.4.3. Short-term Training

SL. No. and Name	Place of employment	Title of course	Duration	Location
1985				
66. Rustom Ali	BARI	Pulse Pathology	2 weeks	ICRISAT, India
67. Md. Abdul Hanif	BINA	Library In-house Course	8 weeks	Cornell University, U.S.A.
68. Mrs. Mansura Begum	BARC	" " "	3-1/2 weeks	" "
69. Minaj Uddin Ahmed	BARC	" " "	3-1/2 weeks	" "
70. Quadir Mahmud, P.S. to Minister	MDA	Institution Management Program	5-1/2 weeks	Washington, U.S.A.
71. Misbah Uddin	BAU	Soil Management	2 months	AIT, Thailand
72. A.B.M. Mahbubui Alam	BAU	" " "	2 months	" "
73. Md. Badiuzzaman	BAU	" " "	2 months	" "
74. Mayeen Uddin Ahmed	BAU	Plant Nematodes	1.4 months	New York, North Carolina, California, U.S.A.
75. Hasan Ashrafuzzamen	BAU	Plant Pathology	1.0 month	Maryland, Florida, New York, North Carolina, U.S.A.
76. Amzad Hossain	BARC	Social and Tech. Aspects of Irrigation Org.	1.5 months	Colorado, U.S.A.
77. Mir Md. Waliul Islam	DU	" " "	2 months	" "
78. Md. Shafiur Rahman	DU	" " "	2 months	" "
79. Shahjahan Akanda	DU	" " "	2 months	" "
80. Md. M. R. Bhuiyan	BARC	" " "	2 months	" "
81. Abdur Rahman	BJRI	" " "	2 months	" "
82. Nurul Islam	BARI	" " "	2 months	" "
83. Matiur Rahman Khan	BAU	Irrigation Design Evaluation and Scheduling	7 weeks	Utah State, U.S.A.
84. Dr. Azizur Rahman	MOH & POP CON	Project Implementation in Agriculture and Rural Development	6 weeks	U.S.A.
85. Dr. Arshad Ali	BAU	Social and Technical Aspects of Irrigation Organization	7 weeks	Colorado State, U.S.A.

6.4. Overseas Training (continued).
6.4.3. Short-term Training

SL. No. and Name	Place of employment	Title of course	Duration	Location
86. Dr. Amjad Hossain	RDA Bogra	" " "	7 weeks	" "
87. Dr. Tofazzal Hossain	BWDB Rangpur	" " "	7 weeks	" "
88. Dr. A. M. Faroque	BAU	Vegetable Production & Marketing	8 weeks	Rutgers Univ., N.J., U.S.A.
89. Mr. M. A. Quadar	BJRI	Crop Management	7 weeks	Cornell & Oklahoma Univ., U.S.A.
90. Mr. Manjur Ahmed	BARI	Agricultural Economics	2 months	IRRI, Philippines
91. Ruhul Amin	BARI	Irrigation & Water Management	5-1/2 weeks	" "
92. Abid Hossain		Cowpea & Soybean Research and Production Technology	7 1/2 months	IITA, Ibadan, Nigeria
93. Dr. Majbahuddin Ahmad	BAU	Rotavirus Associated with Diarrhoea Research	3 months	Kister Institute, Philadelphia, U.S.A.
1986				
94. Abul Karim	BARC	Int'l Development -- Public Policy	1.4 months	Washington, D.C., U.S.A.
95. A. Matin Akhanda	BAU	Project Analysis for Agricultural and Rural Development	5-1/2 weeks	USDA, U.S.A.
96. Shaneed Dad Khan	BAU	Management of Government Organization in Developing Countries	6 weeks	" "
97. Janibul Hoque	LGRD	Social and Technical Aspects of Irrigation Organization	5-1/2 weeks	" "
98. Shafiuddin	BARC	Training on Drainage	6 weeks	Utah State Univ., U.S.A.
99. Hofazzul Karim	MOA	Training on Public Enterprise Workshop	5-1/2 weeks	HIID, U.S.A.
100. Sirajul Islam	DU	Training Course on Biological Nitrogen Fixation	6 weeks	Bangkok, Thailand
101. M. A. Samad Talukder	BARC	Training of Trainers	1 week	Washington, D.C., U.S.A. Staff College, UK
102. Hazrat Ali	STI	Training of Trainers	1 week	Wasshington, D.C., U.S.A.

6.4. Overseas Training (continued).
6.4.3. Short-term Training

SL. No. and Name	Place of employment	Title of course	Duration	Location
103. Abdul Momen	STI	Training of Trainers	1 week	" "
104. Dr. Nurui Alam	BARC	Research Management Course		" "
105. Jalaluddin Sarker	BARI	Training Course on Soil Plant Analysis	3-1/2 weeks	U.S.A.
106. Aminul Islam	BJRI	Lignolauvlosic Materials Training	8 weeks	Seattle Univ., U.S.A.
107. M. Ataur Rahman	BAU	In-service Training	1 month	Texas, U.S.A.
1987				
108. Abul Hossain	BAU	Drainage & Salinity Control	1.4 months	Utah, U.S.A.
109. Afzal Hossain	BAU	Food and Nutrition	2.9 months	Washington, Hawaii, U.S.A.
110. Anowar Hossain	BARI	Soil and Plant Analysis	1.8 months	Cornell, New York, U.S.A.
111. Abdus Satter	BARI	Artificial Rearing of Green Lacewing Fly	1.4 months	" "
112. Atawar Rahman	BAU	Microbiology	6.0 months	Texas, U.S.A.

6.4. Overseas Training.
6.4.4. International Conferences/Study Tours.

SL. No. and Name	Place of employment	Title of course	Duration	Location
1982-1983				
1. Dr. Abul Hasnath	BAU	5th World Conference on Animal Production	1 week	Tokyo, Japan
2. Mr. M. U. Ahmed	BAU	4th International Conference on Plant Pathology	1 week	Melbourne, Australia
3. Mr. A. Halim	BAU	Symposium on R&D	2 weeks	Canada
4. Dr. M. M. Rahman	BARI	Prepare and Consult with ICAR Experts Animal Production	1 week	India
5. Mr. M. M. Miah	BARC	" " "	1 week	" "
6. Mr. K. M. Ejazul Hoq	MDA	" " "	1 week	" "
7. Dr. A. Hannan	BAU	To Visit Indian Irrigation Program	2 weeks	" "
8. Dr. S. H. Khan	SALNA	9th International Congress of Genetics	2 weeks	" "
9. Mr. M. A. Q. Shaikh	INA	" " "	2 weeks	" "
10. Dr. A. Karim	BAU	" " "	2 weeks	" "
11. Mrs. Jinnat Ara Begum	BAU	4th Asian Dan on Nutrition	4 days	Thailand
12. Dr. M. V. Ahmed	BAU	Bionomics Host Para Rel and Control of an Parasites	3 days	India
13. Dr. Shahajahan Ali	BAU	16th Annual Convention of ISNAL	2 days	" "
14. Mr. M. R. Talukder	BAI	Visit Different Agricultural Institutes/Univ. in India	17 days	" "
16. Mr. Yusuf Miah	BARI	Vertebrate Pest Conference	4 weeks	U.S.A.
17. Dr. M. A. Mannan	BARC	Visit to U.S.A. & CIMMYT	23 days	U.S.A. and CIMMYT
18. Mr. Ahmed Mozaharul*	BARC	Symposium on Mechanics and Engineering in Agriculture	5 days	Turkey
19. Dr. Ali Newaz	BAU	Visit Khana House Calcutta	11 days	India

* Some funding from Bangladesh Biman.

6.4. Overseas Training (continued).
6.4.4. International Conferences/Study Tours.

SL. No. and Name	Place of employment	Title of course	Duration	Location
20. Dr. A. Hannan	BUET	Congress on Irrigation and Drainage of ICID	12 days	U.S.A.
21. Dr. Z. Karim	BARI	Soil Science Conference	2 weeks	Thailand
22. Dr. M. Hannan	BARI	" " "	2 weeks	" "
23. Mr. S. M. Hussain Saif	BARC	Agricultural Engineering	2 weeks	India and Pakistan
24. Dr. S. M. Ruhul Amin	BARC	To Attend Forage and Fuel Production from Salt Affected Waste Level	9 days	Australia
25. Dr. Ishaque	BAU	15th Annual Convention and Symposium of Indian Society of Agricultural Chemists	2 days	India
26. Dr. Hefazuddin Shaikh	BAU	5th National Congress of Parasitology	3 days	India
1984				
27. Mr. Anwarul Kibria + 10 farmers		Farmers Visit	10 days	Philippines
28. Mr. M. U. Ahmed	BARI	Crop Loss Assessment	11 days	Minnesota, U.S.A.
29. Dr. Idris Ibnal Azim	BARI	" " "	11 days	" "
30. Mr. Md. Mostaque Ahmed	BARI	Cropping Systems Monitoring Tour	2 weeks	Philippines and Bangkok
31. Dr. Abdur Rahman		Plant Diseases	2-1/2 weeks	Thailand
32. Mr. M. K. Shafiquddin	DAE	" "	2-1/2 weeks	" "
33. Dr. Lutfur Rahman Khan	BAU	4th International Conference Hydraulic Research	4 days	Chiang Mai, Thailand
34. Miss. Jinnat Ara Begum	BAU	Visit (Potato)	3 weeks	CIP, Lima, Peru
35. Mr. Kamal Uddin Ahmed	BARC	Farming Systems Research Symposium	12 days	Kansas State Univ., U.S.A.
36. Dr. M. A. Gaffer	BAU	First Tropical Weed Science Conference	2 weeks	Songkhla, Thailand

6.4. Overseas Training (continued).
6.4.4. International Conferences/Study Tours.

SL. No. and Name	Place of employment	Title of course	Duration	Location
37. Mr. Jahiruddin Chowdhury	BARI	6th International Conference on Mechanization of Field Experiments	2 weeks	Dublin, Ireland
38. Mr. Fouzal Kamal	BARI	" " "	2 weeks	" "
39. Dr. Hafezur Rahman	BAU	6th International Congress of Parasitology	10 days	Veg. Res. Institute, Izzat Nagar, India
40. Mr. Mirza Amirul Islam		International Workshop on Soil Erosion & Countermeasures	1 week	Chiang Mai, Thailand
1985				
41. Dr. S. M. Bulbul	BAU	Poultry Research	8 weeks	Ashford, UK
42. Mr. Rustom Ali		Poultry Pathology	2 weeks	ICRISAT, India
43. Dr. Abdur Rahman	BARC	Workshop on Soybean Utilization	12 days	Colombo, Sri Lanka
44. Dr. M. H. Shahadat Hossain	BARI	Social Indicators for Asia and Pacific Regions	12 days	Manila, Philippines
45. Mr. Abdus Sobhan	BAU	" " "	12 days	" "
46. Dr. Lutfur Rahman	BAU	44th Annual Conference of the Indian Society of Agricultural Economics	4 days	Orissa Univ., Brebanewsar, India
47. Mr. Nurul Huda	Bangladesh observer	Communication & Journalism	7-1/2 weeks	Manila and UPLB, AIT, Bangkok
48. Mr. Akram Hossain	ITTEFAQ	" " "	7-1/2 weeks	" "
49. Mr. A. S. M. Ziaul Karim	BAU	Study Tour Haryana Agriculture University, Hissar and IARI	2 weeks	New Delhi, India
50. Dr. Ashraf Ali Khan	BAU	Study Tour, Asian Universities and Research Centres	1 month	Indonesia, India, and Pakistan
51. Dr. M. A. Hasnath	CASR	" " "	1 month	" "
52. Dr. Abdul Halim	STI	" " "	1 month	" "

6.4. Overseas Training (continued).
6.4.4. International Conferences/Study Tours.

SL. No. and Name	Place of employment	Title of course	Duration	Location
53. Mr. A. K. M. Mokbul Islam	BAU	" " "	1 month	" "
54. Dr. S. M. Altaf Hossain	BAU	Monitoring Tour of Cropping Systems Sites	1 week	Thailand
55. Dr. Z. H. Bhuiya	BAU	Rhizobium Conference	5 days	Waikiki, Hawaii, U.S.A.
56. Dr. M. A. Jabbar	BAU	19th International Conference on Economics	9 days	Malaga, Spain
57. Mr. Md. Farooque	BAU	International Workshop on Enzyme Immunu Assay Techniques in Animal Protection and Health	12 days	Bangkok, Thailand
58. Dr. Lutfun Hossain	BAU	5th International Congress Society for the Advancement of Breeding Researches in Asia and Oceania (SABRAD)	4 days	Bangkok, Thailand
59. Dr. Shah-e-Alam	BAU	" " "	4 days	" "
60. Dr. S. N. I. Salehuzzaman	CU	" " "	4 days	" "
61. Mr. Anwar Iqbal	BARC	Study Tour on Tillage Operations	2 months	ICRISAT, USA/Nigeria
62. Dr. Abul Hasnath	CASR	3rd Annual Science Conference	5 days	Seoul, Korea
63. Md. Abdul Matin Talukder	BOGRA	In-house Training at Pccarrd	4 weeks	Philippines
64. Mr. A. Jalil Bhuiyan	BARI	International Seminar on Mango	2-1/2 weeks	India
65. Mr. Al Amin		" " "	2-1/2 weeks	" "
66. Dr. Hasan Ashrafuzzaman	BAU	Plant Pathology Conference followed by Study	3-1/2 weeks	Maryland, U.S.A.

6.4. Overseas Training (continued).
6.4.4. International Conferences/Study Tours.

SL. No. and Name	Place of employment	Title of course	Duration	Location
1986				
67. Mr. Akhtaruzzaman	BAU	Dry Solar Conference	5 days	Bangkok, Thailand
68. Dr. Shekh Hefazuddin	BAU	Parasitology Conference	12 days	Lucknow and Dydrabad, India
69. Dr. A. Halim	STI	Women Extension Program in U.S.A.	10 days	Washington, D.C.
70. Dr. Z. H. Bhuiya	BAU	Study Tour on Pulse	10 days	New Delhi, India
71. Dr. G. M. A. Pakir	BAU	" " "	10 days	" "
72. Dr. M. Shahjahan Ali	BAU	Conference on Energy from Biomass and Waste	4 days	Washington, D.C.
73. Mr. M. A. Hani[illegible]	BARC	Accountancy Study	3 weeks	Winrock Headquarters, AR, U.S.A.
74. Mr. Islam Uddin Mondal	BARC	" " "	3 weeks	" "
75. Mr. Belayet Hussain Sikder	BARI	Meeting on Plant Genetics	2 days	Rome, Italy
76. Dr. G. Shahe Alam	BAU	Fertility of Large Animals Conference	4 days	Bristol, UK
77. Dr. Mafizur Rahman	SRTI	19th ISSCT Congress	2 weeks	Thailand, Jakarta, Indonesia
78. Dr. Shah-e-Alam	BAU	Workshop on Peanut	5 days	Thailand
79. Dr. Shahidul Islam	BARI	Soil and Fertilizer Management Conference	5 days	Nanjing, China
80. Dr. M. Omar Ali	BARC	18th IVFRD World Congress and Forest Research Workshop	2 weeks	Yugoslavia
81. Dr. Mahbubar Rahman	BARI	Study Tour on Pest Management	2 weeks	Philippines
82. Dr. Monwar Hossain	BARI	Visit Germplasm Collection	6 days	Thailand
83. Mr. Ashraful Islam	RARS	Literature Review for In-country Ph.D. Thesis	2-1/2 weeks	IARI, New Delhi, India
84. Mr. Ali Ahmed	BARI	" " "	2-1/2 weeks	" "
85. Mr. Lutfur Rahman	BJRI	" " "	2 weeks	Calcutta, India

Table 6.5. In-country Training.
6.5.1. Ph.D.

Name	Field of Study	University	Date of Arrival and Departure
1. S. Mahbubur Rahmaan	Soil Science	Dhaka Univ.	Oct. 1982-Oct. 1982
2. Ali Ahmed	Plant Breeding	BAU	June 1983-June 1987
3. Ashraful Islam	Agronomy	BAU	July 1983-July 1987
4. Ataur Rahmoan	Livestock	BAU	July 1983-July 1987
5. Abul Basher	Ag. Economics	BAU	Oct. 1983-Oct. 1987
6. Masood Ahmed	Agronomy	BAU	Feb. 1984-Feb. 1987
7. A.S.M. Ziaul Karia	Ag. Extension/Training	BAU	Feb. 1984-Feb. 1987
8. Muyeen Uddin Ahmed	Plant Pathology	Dhaka Univ.	Aug. 1984-Aug. 1988
9. Mazibur Raman	Soil Science	BAU	Sept. 1984-Sept.1987
10. Matiar Rahman	Ag. Extension/Training	BAU	Nov. 1984-Nov. 1988
11. Abdul Hoq	Livestock	BAU	Nov.1984-Nov. 1988
12. Lutfur Rahman	Agronomy	BAU	March 1984-March 1989
13. Enamul Hoq	Agronomy	BAU	March 1984-March 1989
14. Monjur Majid	Ag. Economics	BAU	July 1985-July 1989
15. A. Samad	Gen. Animal Science	BAU	Oct. 1985-Oct. 1989
16. A. Majid	Animal Breeding	BAU	Oct. 1985-Oct. 1989
17. A.K.M. Quadrat-e-Khuda	Entomology	Dhaka Univ	Jan. 1986-April 1989
18. Sayed Ali Iman	Agronomy	BAU	April 1986-April 1989

Table 6.5. In-country Training.
6.5.2. M.S.

Name	Field of Study	University	Date of Arrival and Departure
1. Murshidul Hoq	Agronomy	BAI	Feb.1984-Aug.1985
2. Ashratun Nessa	Agronomy	BAU	April 1984-Oct. 1985
3. Zebun Nessa	Entomology	BAU	March 1984-Sept. 1985
4. S. M. Saiful Hasan	Soil Physics	BAU	Feb. 1984-Aug. 1985
5. Rezaul Kabir	Soil Microbiology	BAU	March 1984-Sept. 1985
6. Md. Fazlul Karim	Agronomy	BAU	Feb. 1984-Aug. 1985
7. Mainui Islam	Ag. Economics	BAU	Feb. 1984-July 1985
8. Ittafaqul Azad	Horticulture	BAU	Aug. 1984-Feb. 1986
9. Golam Mustafa	Plant Breeding	BAU	Aug. 1984-Feb. 1986
10. Shamsui Hoq	Plant Breeding	BAU	Aug. 1984-Feb. 1986
11. Suranjan Kumar Shaha	Horticulture	BAI	Sept. 1984-March 1986
12. A.K.M. Azmal	Soil Mircobiology	BAU	Sept. 1984-March 1986
13. Naresh Chandra Deb Barman	Plant Breeding	BAI	Sept. 1984-March 1986
14. Rezaul Karim	Ag. Extension	BAU	Sept. 1984-March 1986
15. Mahbub Uddin Ahmed	Plant Pathology	FAU	Sept. 1984-March 1986
16. Nurul Alam Khan	Agronomoy	BAU	Sept. 1984-March 1986
17. Shamsun Nahar BEgum	Soil Science	BAU	March 1985-Sept. 1986
18. Majibur Rahman	Ag. Engineering	BAU	March 1985-Sept. 1986
19. Masood Alam	Veterinary Medicine	BAU	March 1985-Sept. 1986
20. Habibur Rahman	Veterinary Parasitology	BAU	March 1985-Sept. 1986
21. Nurun Nahar	Animal Breeding	BAU	April 1985-Oct. 1986
22. Emdadul Hoq	Gen. Animal Science	BAU	April 1985-Oct. 1986
23. Mujaffar Hussain	Gen. Animal Science	BAU	April 1985-Oct. 1986
24. Nazrul Islam	Veterinary Microbiology	BAU	April 1985-Oct. 1986
25. Tazul Islam	Economics	BAU	Feb. 1984-July 1985

Table 6.5. In-country Training.
6.5.3. Short-term Training.

Course Title	Duration	Venue	No. of Trainees
1982-1983	Jan.-June 1983		
1. On-farm Water Management	15 days	BAU/BARC	21
2. Soil Fertility	14 days	BARC/BAU	22
3. Irrigation Fertilizer Management	11 days	CERDI	34
4. Cropping Systems	13 days	BRRI	30
5. Potato Production	6 days	BARI	84
6. rice Production (for farmers)	6 days	BRRI	40
7. Vegetative Propagation of Fruit Trees	2 days	RARS	20
8. Farm Survey and Data Analysis	15 days	BARC	15
9. Descriptive Statistics	10 days	Jessore	10
10. Descriptive Statistics	10 days	Hathazari	10
11. Descriptive Statistics	10 days	Jamalpur	10
12. Descriptive Statistics	10 days	Ishurdi	10
13. Documentation and Reprography	7 days	BARC	22
14. Agricultural Documentation	14 days	BARC	21
15. Caris/Agrovoc	4 days	BARC	15
16. Research Method and Evaluation	16 days	BAU	30
17. Acctng. for Contract Res. Investigators	20 days	BARC/BAU	60
18. Training on Monitoring and Evaluation	4 days	BARC	24
19. Training on Agricultural Communication	6 days	BARC	40
20. National Rat Control in Wheat	3 days	Dinajpur/Rangpur/Bogra	24
21. Vegetative Propogation of Fruit Trees for TEDS	3 days	Hathazari	20
22. Training on Farm Technology Orientation for Journalists	5 days	BARC	22
23 Gas Welding and Arc Welding	2 months	BOL	2
24. Diagnostic Analysis of Farm Systems	1 month	BARI	27
25. Postharvest Training Program on Potato	7 days	BARI	20
1983-1984			
26. Training on Repair and Maintenance of Farm Machinery and Equipment	14 days	BARI	15
27. Oil Crops Training for Ext. Officers	19 days	BARI	75
28. Cropping System Training	19 days	BARI	26
29. Library and Documentaiton Training	12 days	BARC	22
30. Communication Extension and Management	10 days	GTI, BAU	25
31. Application of Statistics in Ag. Res.	3 weeks	BARI	29
32. Farm Operations and Management In-country Training on Crop Water	2 weeks	BARI	20
33. Budgeting & Farm Layout for Irrigation	7 weeks	Jessore	15
34. Budgeting & Farm Layout for Irrigation	1 week	Ishurdi	15
35. Budgeting & Farm Layout for Irrigation	1 week	Jamalpur	15
36. Budgeting & Farm Layout for Irrigation	1 week	Hathazari	15
37. In-country Training Program on Maize to the Field-men of On-farm Trial	3 days	BARI	45
38. In-country Training on Basic Principles and Procedures of Jute Research	5 days	BJRI	25

Table 6.5. In-country Training (continued).
6.5.3. Short-term Training.

Course Title	Duration	Venue	No. of Trainees
39. Vegetable and Citrus Training	2 days	BARI	20
40. Efficient Use of Fertilizer on Irrigation Water Crop Production	19 days	GTI	25
41. Soil Improvement and Management	5 days	BAU	40
42. Training on Descriptive Statistics	12 days	GTI	25
43. Training on Crop Production and Extension Mngmt. Spec. Trn. Course	3 months	BARI/CERDI/RARS of BARI	22
44. Training Course for Instructors of AETI	3 weeks	CERDI	24
45. Training Course for Instructors of AETI	3 weeks	CERDI	24
46. Training Course for Instructors of AETI	3 weeks	CERDI	24
47. Training of Farm Mechanics and Farm Machine Operators	4 days	BARI, Ishurdi, Hathazari	56
48. Training Importance of Production and Consumption of Potato as an Alternative Food	2 weeks	BARI	20
49. In-country Training on Laboratory Training on Soil and Plant Analysis	10 days	BARI	8
50. Training on Biological Fixation Research/Extension	9 days	BARI	35
51. Office Management Training Course	6 weeks	RAPPORT BANGLADESH	2
52. Postgraduate Diploma Course on Personnel Management	1 year	BMDC	1
1984			
53. Irrigation Water Management for Crop Protection	18 days	BRRI	20
54. Fertilizer Efficiency Research Training	4 days	BARI	25
55. Rice Cropping System	11 days	BARI	25
56. Soil and Fertilizer Management	12 days	BRRI	25
57. Training of SMOs of Teaching and Techniques Agricultural Related Subjects and Management	3 weeks	CERDI	48
58. Analysis of Economic Research Data	1 month	RDA, Bogra	17
59. Training on Power Equipment and Its Maintenance	1 week	BUET	3
60. Water Management Training	1 month	BARI	20
61. Analysis of Economic Research Data	1 month	GTI, BAU	??
62. Office Management	6.5 weeks	RAPPORT BANGLADESH	5
63. Elementary Price Analysis	1 month	BARD, Comilla	11
64. Training Course on Descriptive Stats.	5 weeks	GTI, BAU	25
65. Training Course for Seed Certification Agency Personnel	1 month	CERDI	25
66. Application of Statistics in Agri. Res.	3 weeks	BRRI	26
67. Fertilizer Efficiency Research and Refresher Course	2.5 weeks	BARI	34
68. Training on Vertegrate Pest Mgmnt.	5.5 weeks	RARS	??
69. Training on the Management of Agric. Research Organizations	2.5 weeks	IPSA	25
70. Training on Company Management and Corporate Affairs	8 days	RAPPORT BANGLADESH	1
71. Pump Awareness	4 days	BARI	18
1985			
72. Staff Management	2 weeks	Inst. of Publ. Admn.	2
73. Accountancy	9 days	RAPPORT BANGLADESH	8

Table 6.5. In-country Training (continued).
6.5.3. Short-term Training.

Course Title	Duration	Venue	No. of Trainees
74. Diffusion of Technology	16 days	IPSA	26
75. AGricultural Research Management	3 days	BMDC	1
76. Communication Skills for Researchers	2 days	BARC	25
77. Communication Skills for Researchers	2 days	BARC	22
78. Communication Skills for Researchers	2 days	BARC	28
79. Workshop for Editor of Agricultural Science Journals	5 days	BARC	22
80. Farming Systems Research Methodology	3 weeks	BARI	20
81. Course for Vegetable Growers	2 days	CVSR, Rangpur	50
82. Course for Vegetable Growers	2 days	CVSR, Ishurdi	50
83. Course for Vegetable Growers	2 days	CVSR, Joydebpur	75
84. Vegetable Seed Production and Quality Control Course for BADC Officers	6 days	BARI	20
85. Course for Citrus Growers	2 days	Ishurdi	50
86. Horticultural Nursery Course	1 week	BAI	20
87. Applications of Microcomputers	16 days	BARC	8
88. Applications of Microcomputers	17 days	BARC	3
89. Descriptive Statistics	2 weeks	GTI	25
90. Descriptive Statistics	2 weeks	GTI	16
91. Rural Research and Rural Policy	12 days	BARC	16
92. Feed and Fodder Prod. and Utilization	2 weeks	Savar	20
93. Cattle and Buffalo Devlp. and AI Ext.	12 days	Savar	20
94. Soil Fertility	5 days	BRRI	30
95. Soil Fertility	5 days	BRRI	32
96. Biological Nitrogen Fixation	1 week	GTI	30
97. Analytical Chem. and Instrumentation	6 days	BARI	15
98. Pump Irrigation in Bangladesh	5 days	GTI	30
99. Indigenous Irrigaiton Pumps	2 weeks	IPSA	20
100. Irrigation Water Production Functions	4 weeks	BARI	21
101. Pump Irrigation in Bangladesh	6 days	Jessore RARS	30
102. Groundwater Investigations	4 weeks	BRRI	30
103. Irrigation and Fertilizer Management at Farm Level	2 weeks	CERDI	34
104. Integrated Pest Management	12 days	BARI	24
105. Experimental Design and Analysis for Entomologists	6 days	BARI	17
106. Plant Disease Diagnosis	5 days	BARI	18
107. Plant Disease Diagnosis	5 days	RARS Ishurdi	17
108. Remote Sensing Techniques for Agric. Research (for AID level scientists)	3.5 weeks	SPARRSO	26
109. Remote Sensing Techniques for Agric. Research (for senior level scientists)	2 days	SPARRSO	15
110. Word Processing on Microcomputers	1 week	BARC	8
111. MSTAT I	10 days	BARC	13
112. MSTAT II	12 days	BARC	9
113. Meristem-tip Culture of Bananas	6 days	BARI	6
114. Training on IBM System-36	2 weeks	IBM Center, Dhaka	1
115. Fundamental Analystical Chemistry and Instrumentation	6 days	BARI	12
116. Two Levels of Hands-on Training on Instrument Repari and Maintenance	3 weeks	BARI/RARS/BAU/BINA	6
117. Livestock and Poultry Research Methodology	2 weeks	BLRI, Savar	25

Table 6.5. In-country Training (continued).
6.5.3. Short-term Training.

Course Title	Duration	Venue	No. of Trainees
1986			
118. Biological Nitrogen Fixation	1 week	BRRI	35
119. Training on Soil Fertility	1 week	IPSA, Salna	30
120. Research Methodology of Rural Dvlpmnt.	3 weeks	BARD, Comilla	21
121. Groundwater Irrigation Course	1 month	BRRI	30
122. Descriptive Statistics (5th batch)	10 days	GTI	25
123. Training of BADC Engineers about Fabrication, Operation, and Maintenance of Locally-developed Power Tiller	1 week	BRRI	15
124. 4-day Training for Research Entomologists and Plant Pathologists on Pesticide Use and Safety	4 days	BRRI	20
125. Training on System Approach to Water Resource Planning and Management	5 days	BUET	20
126. " "	"	BARD	25
127. Training on Office Management	2 weeks	RAPPORT BANGLADESH	15
128. Farmer's Training	3 days	Hathazari	100
129. Training on Descriptive Statistics	2 weeks	GTI	25
130. Basic Electricity and Electronics for Laboratory Maintenance	6 days	BARI	20
131. Training for S.D. and Field Man on Soil Physics	10 days	BAU	17
132. Training on Price Analysis	6 weeks	BARC	20
133. Video Camera Use and Preparation of Research and Training VCR Film	6 days	BARC	6
134. Training on Pump Irrigation (3rd)	6 days	GTI	24
1987			
135. Livestock in Farming Systems Research	6 days	BLRI, Savar	25

6.5. In-country Training.

6.5.4. Seminars, Workshops, and Conferences.

Course Title	Duation	Venue	No. of Participants
1982-1983			
1. Workshop on Improved Method of Potato Cultivation in Rangpur District	2 days	BARI	100
2. Workshop on 1st National Seminar on Fisheries Research in Bangladesh	2 days	BARC	76
3. 1st Workshop on National Cropping Systems Research	4 days	BARI	50
4. Field Day	1 day	RARS, Jessore	200
5. Field Day Cropping Systems	1 day	KANHER and VJAN BOILER	150
6. Postharvest Training Program on Potato	1 day	BARI	20
7. Research and Extension Day	1 day	RARS, Jamalpur	50
8. International Review Workshop for Rabi Season	4 days	BARI	60
9. Seminar on Fish Research in Bangladesh	2 days	BARC	100
10. Printing Program of the Rat Control Campaign in Wheat	1 day	BARI	30
11. Installation of Turbine Pumps	1 day	RARS, Jessore	25
12. " "	"	RARS, Jessore	25
1983-1984			
13. 1st National Workshop on Livestock Research in Bangladesh	2 days	BARC	76
14. Workshop on Internal Evaluation of BARI Irrigation and Water Management Program	2 days	BARC	??
15. InterCongress Conference under Commission V on Soil Test Crop Research Correlation of the International Society of Social Science	4 days	BARC	200
16. Meet Up the Operational Expense of the Potato Project	1 day	BARI	?
17. InterCongress Meet the Scientist Day	1 day	RARS, Hathazari	?
18. Aquacultural Economics Workshop	3 weeks	?	18
1984			
19. Workshop on Improved Distribution for Minor Irrigation in Bangladesh	2 days	BARC	75
20. Regional Workshop on Research Program Evaluation	3 days	BARC	50
21. Workshop on Socioeconomic Research Projects	1 day	BARC	50
22. Research Workshop on Soils	3 days	BARC	90
23. Farmers' Training	1 day	Sylhet	550
24. Improved Methodology of Pommelo Propogation and Cultivation	2 days	RARS, Ishurdi	250

6.5. In-country Training (continued).
6.5.4. Seminars, Workshops, and Conferences.

Course Title	Duation	Venue	No. of Participants
25. Training of Citrus and Vegetable Farmers	2 days	?	155
26. Soil Fertility Constraints in Tea Production	1 day	BTRI	12
27. Training Needs Assessment and Training Tips	1 day	BARI	?
28. Cropping Systems Research	1 day	Jamalpur	3
29. " " "	"	Rajshahi	4
30. " " "	"	Jessore	2
31. Review of Cropping Systems Research	?	Ishurdi	100
32. Agronomic Practices for SMS	?	Jessore	1
33. " " " Contact Farmers	?	RARS, Jessore	?
1985			
34. Workshop on Agricultural and Technological Research on Jute	?	BJRI	100
35. Workshop on Integrated Pest Management	?	BARC	50
36. National Seed Technology Workshop I	2 days	BJRI	?
37. Discussion Seminar on Crops	2 days	BARC	45
38. National Seminar on Fisheries Management in Bangladesh	"	"	75
39. Discussion Seminar on Animal Husbandry	"	"	45
40. Discussion Seminar on Soils	"	"	45
41. Discussion Seminar on Agricultural Engineering and Irrigation	"	"	45
42. Discussion Seminar on Fisheries	"	"	45
43. Discussion Seminar on Forestry	3 days	"	45
44. Problems and Prospects of Mango Production	2 days	"	115
45. 1st National Conference on Animal Hus.	1 week	"	350
46. Farming Systems Socioeconomic Research	2 days	"	60
47. International Symposium on Potassium in Agricultural Soils	2 days	"	100
48. Refining Research Priorities on Livestock and Poultry	1 day	"	100
49. National Symposium on Potato Food Production	3 days	"	50
50. 1st National Conference of Bangladesh Phytopathological Society	2 days	"	50
51. Workshop on Present Status and Future Prospects of Research on Root Crops and Spices	1 day	"	60
1986			
52. International Symposium on Minimum Tillage	5 days	BARC/Field tour	70
53. International Workshop on Human Resources Management	3 days	BARC	70
54. Workshop on Interspecific Hybridization on Jute Kenaf and Mesta	1 day	BJRI	250
55. Seminar on Socioeconomic Aspects of Developing the Fisheries Resources in Bangladesh	1 day	BAU	15

6.5. In-country Training (continued).
6.5.4. Seminars, Workshops, and Conferences.

Course Title	Duation	Venue	No. of Participants
56. Workshop on Soil Sampling and Fertilizer Recommendation	2 days	BARI	75
57. " " " "	2 days	RARS, Sihurdi	25
58. " " " "	2 days	RARS, Jessore	25
59. " " " "	2 days	RARS, Hathazari	25
60. International Symposium on Sulphur in Agricultural Soils	3 days	BARC	150
61. Workshop on Pesticide Safety and the use of Pesticide Manual	5 days	BARI	30
62. Technical Discussion on Fertilizer Nitrogen Deep Placement for Rice	2 days	BARC	75
63. Workshop on Low Water Cropping Patterns for Irrigation Agriculture	2 days	"	120
64. Workshop on Commercial Poultry Farming	2 days	"	75

6.5. In-country Training.
6.5.5. Sabbatical Leave

SL. No. and Name	Field of Study	Date Commenced	Location
1. Dr. Md. Hussain Professor, BAU	Biochemistry	June 1983	BARI
2. Dr. Shamsul Huda Chowdhury Professor, BAU	Crop Botany	June 1983	BARI
3. Mr. A. L. Bhuiyan Chittagong University	Marine Biology (Plankton)	March-December 1984	SHAHINDOR, MFRC, PATENGA, Chittagong
4. Mr. Sadrul Amin Potuakhali Krishi College Dumki	Soil Fertility and Microbiology	May 1984-January 1985	BARI/BRRI, Joydebpur
5. Mr. M. A. Wahab PSO, BARI	Plant Breeding and Genetics	October 1984-March 1985	BARI/BRRI, Joydebpur
6. Mr. M. A. Khaleque Project Director, BARI	Agronomy	October 1984-March 1985	BARI/BRRI, Joydebpur
7. Dr. A. Jalil Miah	Tissue Cultures	July 1985-July 1986	Dhaka University
8. Dr. Ashraf Ali Professor, BAU		January-June 1986	
9. Dr. M. L. Dewan Professor, BAU		April-September 1986	

6.6. Contract Research.
6.6.1. Farming Systems Research.

Project Title	Principal Investigator	Duration
1. Cropping Systems Research and Development Program at Ishurdi and Rangpur	Dr. Joynal Abedin	7/83 - 6/86
2. National Coordinated Farming Systems Research Project		
a) Laharikanda - Jamalpur	Mr. A. B. M. Abul Khair, BARI	7/85 - 6/86
b) Naogaon - Kishorgonj	Dr. S. M. Altaf Hossain	" "
c) Faridpur	Dr. M. A. Khan Majlish	" "
d) Janakinathpur - Rangpur	Mr. Md. Habibur Rahman	" "
e) Kalikapur - Ishurdi, Pabna	" "	" "

6.6. Contract Research.
6.6.2. Economics and Social Science Research.

	Project Title	Principal Investigator	Duration
1.	Socioeconomic Assessment of Jute based Farming System in Bangladesh	Dr. M. A. Khan Majlish	7/82 - 6/85
2.	Benchmark Survey for Cropping System Research at Chittagong, Jessore, Rangpur, Rajshahi, Bogra, and Thakurgaon	Dr. S. M. Elias	7/80 - 12/84
3.	Role of Rural Women in Technology Adoption and Family Income	Mrs. Shahnaz Hossain	1/84 - 6/85
4.	A Socioeconomic Study of Tubewell Irrigation in Selected Area in Mymensingh District	Dr. M. A. Sattar Mandal	1/84 - 12/85
5.	Rural Urban Dynamics, Household Economics Irrigation and Agricultural Development in Bangladesh	Dr. R. M. Ahsan	7/84 - 12/86
6.	A Study of Land Use Survey in the Irrigation Project Area	Dry Kayser Hossain	7/83 - 12/86
7.	Economics of Supplementary Irrigation of Kharif Crops	Mr. A. J. M. Farooque	5/85 - 11/86
8.	A Comprehensive Technical and Economic Evaluation of Deep Tubewell Irrigation System in Selected Area of Bangladesh	Dr. Azharul Haque	7/84 - 9/86
9.	Response to Shallow Tubewell Running Dry Due to Declining Groundwater Levels	Dr. Ataul Haque	7/85 - 3/87
10.	Chronological Change in Irrigation System in Comilla, BARD	Dr. Kamal Uddin	7/85 - 9/86
11.	Socioeconomic Analysis of Production Marketing and Utilization of Major Oilseeds in Selected Areas of Bangladesh	Dr. Shahadat Hossain	7/85 - 6/88

6.6. Contract Research.
6.6.3. Crops Research.

Project Title	Principal Investigator	Duration
1. Blackgram & Khesari - Components		7/80 - 6/86
a) Coordinators office - BARI, Joydebpur	Mr. Sharafat Hossain	
b) Breeding part - BARI, Joydebpur	Dr. M. A. Wahab/A. Hamid	
c) Breeding part - BINA, Mymensingh	Dr. M. A. Q. Sheikh	
d) Plant Pathology - BAU, Mymensingh	Dr. Golam Ali Fakir	
e) Nodulation Nitrogen - BAU, Mymensingh	Dr. Prof. Z. H. Bhuiyan	
f) Agronomy Physiology - BARI, Joydebpur	Dr. A. F. M. Moniruzzaman	
g) Insect Pest - BARI, Joydebpur	Mr. Md. Nasiruddin	
h) Food & Feed Value - BARI, Joydebpur	Prof. M. Hossain	
i) Breeding part - Rahshahi University	Dr. O. I. Joarder	
2. Development of Root Crops of Bangladesh	Dr. Md. Mamunur Rashid	7/83 - 6/86
3. Studies on the Biology and Control of Mango Shoot Ball, etc	Dr. E. I. Azim	
4. Survey of Deep Water Aus-Aman Mixed Crop Area at Tangail	Mr. M. R. Talukder	
5. Project for Collection and Evaluation of China and Kaon, BARI	Mr. Helalul Islam	
6. A Comprehsnive Study on Weeds & Their Infestation in the Arable Land of Bangladesh, BAU	Dr. M. A. Gaffar	7/85 - 6/87

6.6. Contract Research.
6.6.4. Livestock Research.

Project Title	Principal Investigator	Duration
1. Development of Technology of Culture of Seeds of the Giant Prawn (Microbrachium Resenbergri) for Distribution to Prawn Farmers)	Alhaj Dr. A. L. Bhuiyan	7/82 - 6/84

6.6. Contract Research.
6.6.5. Soils Research.

Project Title	Principal Investigator	Duration
1. Soil Test Response Correlation Studies for Rice, BAU	Dr. Md. Eaqub	7/80 - 6/86
2. Soil Test Crop Response Correlation for Wheat, Cotton, Tobacco, Potato, and Pulses, BARI	Dr. M. Shahidul Islam	7/80 - 6/86

6.6. Contract Research.
6.6.6. Irrigation and Water Management.

Project Title	Principal Investigator	Duration
1. Studies of Soil & Water Management Practices for Crop Production	Dr. Z. Karim/Moinur Rahman	7/80 - 6/86
2. Coordinated Micronutrient Research Under Irrigated & Nonirrigated Conditions		9/82 - 8/85
a) BARI - Joydebpur	Dr. M. Shahidul Islam	
b) BINA - Mymensingh	Mr. Lutfur Rahman	
3. Integrated Project on the Management of Problem Soil Under Irrigated and Nonirrigated Conditions		10/82 - 9/85
a) BINA - Mymensingh	Mrs. Sultana Ahmed	
b) BARI - Joydebpur	Dr. Z. Jarim	
c) BARI - Joydebpur	Dr. M. A. Hannan (Project Incharge)	
d) BAU - Mymensingh	Dr. F. A. Chowdhury	
e) Chittagong - hathazari (BARI)	Mr. F. Hoque/A. Kashem	
f) Srimangal - Sylhet (BTRI)	Mr. M. A. Rahman	
g) Dhaka University	Dr. Ziauddin	
h) Coordinators office - BARI	Dr. Abidur Reza Khondaker	
4. Cropping System Defined Area Project at Jamalpur, BARI	Dr. Jahir Uddin Ahmed/Joynal Abedin	7/83 - 6/86
5. Economics of Irrigation of Bangladesh	Md. Mosharraf Hossain	
6. Efficiency of Bamboo Tubewell for Small Scale Irrigation in Cropping System Area of Jessore	Mr. K. C. Roy/Md. Jahir Uddin Md. Sirajui Islam	7/82 - 6/85
7. Saline Water Irrigation & Crop Production in Coastal Zones of Bangladesh	Dr. I. U. Ahmed	10/83 - 9/86
8. A Study on the Socioeconomic Effects of Flood Disaster in Comilla District	Mr. A. H. M. Adbul Hye	
9. Integrated Irrigation Command Area Development		1/84 - 9/87
a) BAU	Dr. Rafiqui Hoque	
b) BARI	Mr. Harunur Rashid/Md. Ismail Hossain	

6.6. Contract Research (continued).
6.6.6. Irrigation and Water Management.

Project Title	Principal Investigator	Duration
10. Socioeconomic Study of Cropping System Under Irrigated Farming System	Mr. A. Asadullah	
11. National Survey on Performance of Different Types of Tubewell and LLP Equipment (BARI)	Dr. Azharui Hoque	1/85 - 12/86
12. Socioeconomic Study of System Research in Irrigated Project at BWDB	Mr. Majibul Hoque	

6.7. Publications.
6.7.1. Research Systems Management.

Title	Authors/Editors
1. Analysis of Agricultural Research Project Phase II with Special Reference to Modes of Research Development Project Activities and Source of Assistance	Max Lowdermilk
2. Contract Research Program Evaluation	David W. James
3. Master Plan for Bangladesh Agricultural Research Council	R. L. Cushing
4. Annual Plan I - July 1981-1982 II - July 1981-1982	R. L. Cushing
5. Legume Inoculation	Robert J. Davis
6. Accounting Report on BAU and INA	Gary L. Howe
7. An External Review of the Contract Research Program of the Bangladesh Agricultural Research Council	L. F. Hester, D. W. Barton, and Loyd Johnson
8. Report on the May External Evaluation Team Agricultural Research Project Phase-II	Jock Anderson, Kim Bridges, Oleen Hess, and Carl Pray
9. Financial Management System	Alexander Daunys
10. Administration and Financial Accounting	Edward Rosentel
11. Administrative and Financial Procedures	Alexander Daunys
12. Terms of Reference for IADS Specialists	Guy B. Baird
13. Management of Agricultural Organization Report on Training Course, December 1-19, 1984	D. A. Spears and R. Z. Callahan
14. Preliminary Review and Recommendation	Ludwig Eisgruber
15. Review of the Bangladesh Jute Research Institute	J. M. Poehlman
16. Planning Monitoring and Evaluation	Guy B. Baird
17. Annual Work Plan, 1983-1984	Project Supervisor, IADS
18. Six Month Progress Report IV, January-June 1983	" "
19. Six Month Progress Report V, July-December 1983	" "
20. Revised Edition Six Monthly Reports, July 1982-1986	" "
21. Contract Between Government of Bangladesh and IADS	" "

6.7. Contract Research (continued).
6.7.1. Research Systems Management.

Title	Authors/Editors
22. Annual Financial Plan, July 1, 1983 - June 30, 1984	Project Supervisor, IADS
23. Agricultural Research in Bangladesh Contributing to National Development	Theodore Hutchcroft
24. Report of the Review Team Bangladesh Agricultural Research System	" "
25. Management Monitoring and Evaluation of Agricultural Projects Supported with an Information System	M. U. Ahmed and M. D. Dawson
26. Annual Work and Financial Plan, 1985-1986	Project Supervisor
27. Report of External Evaluation Team	F. Riggs, S. M. S. Ali, and Kay Calavan
28. Six Month Progress Report VIII, January-June 1985	Project Supervisor
29. Six Month Progress Report IX, July-December 1985	" "
30. 1986 Internal Evaluation (completed)	David M. Daugherty
31. 1986 External Evaluation	" "
32. Annual Work and Financial Plan, 1986-1987	" "
33. Six Month Progress Report X, January-June 1986	" "

6.7. Publications.
6.7.2. Technical Support Systems.
6.7.2.1. Farm Development.

Title	Authors/Editors
1. Experiment Station Farm Management A View Towards Improvement	Dwight C. Finfrock

6.7. Publications.
6.7.2. Technical Support Systems.
6.7.2.2. Maintenance.

Title	Authors/Editors
1. Analytical Equipment and Instrumentation	R. W. Clayton
2. Analytical Equipment and Instrumentation	Leonard Mattick
3. Analtyical Chemistry and Instrumentation	" "
4. Instrumentation, Equipment Repair, and Maintenance	" "
5. Development of Computerized Facilities at NALDOC	A. M. Woodward
6. Orientation to Video Use at BARC	Melissa Beck Yazman
7. Report of Photographic Consultant from ICRISAT	H. S. Duggal
8. Maintenance Shop Manual	Harvey Carr
9. Farm Machinery Maintenance and Repair	" "

6.7. Publications.
6.7.2. Technical Support Systems.
6.7.2.3. Training.

Title	Authors/Editors
1. Report of Consultancy Visit by Program Training Office, International Agricultural Program , Cornell University	James Haldeman
2. Technical Assistance Training for the Bangladesh Agricultural Research Council	A. H. Thomas

6.7. Publications.
6.7.2. Technical Support Systems.
6.7.2.4. Agricultural Information.

Title	Authors/Editors
1. The Publications Programs of the Bangladesh Agricultural Research Council	Steven A. Breth
2. Training and Communications in and for Bangladesh Agricultural Research Council	Francis C. Byrnes
3. An Evaluation of the Bangladesh Agricultural Research Council Computer Needs	Stephen B. Harsh
4. Technical Course for Editors of Bangladesh Agricultural Science Journal	Anito DeVivo
5. Development of Computerized Library Network	Anthony M. Woodward
6. Developing Library Service for Postgraduate	Melvin R. George
7. Management of Human Resources in Agricultural Research	BARC/ISNAR/WINROCK, Theodore Hutchcroft
8. Ten Years of Agricultural Research in Bangladesh	BARC/Theodore Hutchcroft
9. Evaluating Agricultural Research Programs	BARC/ISNAR/Winrock/Theodore Hutchcroft
10. National Agricultural Research in Bangladesh Contributing to National Development	BARC/Theodore Hutchcroft
11. National Agricultural Research Plan 1984-1989	BARC
12. This is BARC, 3rd Edition	BARC

6.7. Publications.
6.7.3. Farming Systems Research.

Title	Authors/Editors
1. Farming Systems	Richard Harwood
2. Assessment of Research Program and Recommendations for Improving Production Potential in the Jamalpur Area	Ed Perdon
3. Some Research Ideas for Improving the Perennial Subsystem at the Homestead in Bangladesh	Saul E. Camacho
4. Guidelines for Farming Systems Research Methodology	R. E. Hudgens
5. Farming Systems Multilocation Testing Guideline	BARC
6. Farming Systems Pilot Production Program Guideline	BARC
7. The Homestead in FSR: Strategies and Experience from Bangladesh	R. E. Hudgens, Z. Abedin, and M. H. Khan

6.7. Publications.
6.7.4. Economics and Social Science.

Title	Authors/Editors
1. Report on the Program in Agricultural Economics at Bangladesh Agricultural Research Council	Randolph Barker
2. A Preliminary Analysis of the Socioeconomic Dimensions of Farming Systems in a Bangladesh Community	Ben Wallace
3. Applications of Anthropology to Farming Systems Research	Robert V. Kemper, Ben Wallace
4. Village Bangladesh: A Case Study in Applied Anthropology and Farming Systems Research	Ben Wallace
5. Economic Dimensions of Agricultural Research Programs	Robert E. Evenson
6. Social Anthropological Aspects of Farming Systems Research	Ben Wallace, Robert V. Kemper
7. Effects of Food (1984) in Bangladesh	BARD, Kotbari, Comilla
8. Assessment of Quantitative Skills in Agricultural Research	Larry Nelson
9. The Applications of Statistics in Agricultural Research	Pearce Kemson Dyke
10. Anthropology in Farming Systems Research	Ben Wallace
11. A Comprehensive Long-term Cooperative Project to Strengthen Agricultural Credit Research	A. N. Choksi
12. Report on BARC Microcomputer Training Course	Donn F. Davy
13. Womens Work in Rural Bangladesh	Ben Wallace
14. Survey and Sampling Methodology	Doug Neeley
15. Agricultural Economics and Soil Science	Ben Wallace, Robert V. Kemper
16. Farming Systems and the Extended Community	" "
Section A (General)	
17. Shortcourse on Descriptive Statistics (Training Manual)	BARC/AESS, B. A. Greene
18. Final Report Shortcourse on Descriptive Statistics, Four Regional Locations	B. A. Greene
19. Suggested Monitoring Forms for Data Management on Cropping Systems Research Sites (Working Paper No. 1)	B. A. Greene, A. H. Manzano
20. Short Review of a BJRI Contract Research Project	B. A. Greene
21. A Short Report on the Division of Agricultural Economics, BARI, Joydebpur	" "

6.7. Publications (continued).
6.7.4. Economics and Social Science.

Title	Authors/Editors
22. Proposed Annual Plan 1983-1984	BARC/AESS Program
23. Shortcourse on Socioeconomic Data Analysis and Partial Budgets, BJRI, Dhaka (Training Manual)	B. A. Greene
24. Shortcourse on Descriptive Analysis of Agricultural Economics Research Data, RDA, Bogra (Revised Training Manual)	" "
25. Shortcourse on Elementary Price Analysis at Bangladesh Academy for Rural Development (Training Manual)	" "
26. Shortcourse on Descriptive Analysis of Agricultural Research Data (6 days) BARD, Comilla (Training Manual)	" "
27. Shortcourse on Elementary Calculus and Matrix Algebra, (Training Manual) BJRI, Dhaka	" "
28. Using Field Data - The AESS Workshop Paper Series 1984 to 1987 AESS, BARC, Dhaka	" "
Section B (Cropping/Farming Systems)	
29. What Economic Data? June 1982	B. A. Greene
30. Fertilizer Prices, July 1982	" "
31. Some Economic Ratios, July 1982	" "
32. Sample Monitoring, July 1982	" "
33. Socioeconomic Data Analysis on Cropping Systems Research Sites	" "
34. Rice Yield Analysis, Hathazari CSRS, 1981-1982, April 1983	" "
35. Crop Yield Analysis, Jessore CSRS, 1981-1982, April 1983	" "
36. Partial Budgets, May 1983	" "
37. Income Analysis from One Year's Data, Jessore CSRS 1981-1982, November 1983	" "
38. Applying Partial Budgeting to a Fertilizer Trial	" "
39. Labor Use Standards for Selected Crops in Noakhali District, Bangladesh, 1980-1982, May 1984	" "

6.7. Publications (continued).
6.7.4. Economics and Social Science.

Title	Authors/Editors
With Sunil Saha	
40. Labor Use Standards for Jute, 1983-1984, June 1984	B. A. Greene
41. Income Analysis, Hathazari CSRS 1981-1982, June 1986	" "
42. Using Index Numbers with CSRS data, March 1985	" "
43. Crop Yield by Land Type and Farm Size, Hathazari CSRS, 1981-1982, March 1985	" "
44. The Lion or the Mouse: Statistical Training for Agricultural Research, June 1985	" "
45. Economic Aspects of Maize Production in Bangladesh, April 1986	" "
46. Economic Aspects of Cotton Production in Bangladesh, April 1986	" "
47. Economic Aspects of Pulse Production in Bangladesh, April 1986	" "
48. Fertilizer Adoption, Hathazari FSR site, 1981-1982, April 1987	" "
C. AESS Workshop Series	
49. Agroeconomic Analysis of Cropping Patterns Involving Jute and Potato	A. K. Azad and M. N. Nabi
50. Socioeconomic Assessment of Improved Jute Production Technologies	Jibhan Krishna Saha
51. Preliminary Analysis of Livestock Data	S. S. Choudhury, et al.
52. Agroeconomic Study of Country Bean Production	Rexaul Karim, et al.
53. Agroeconomic Analysis of Jute Production	Nurun Nabi, et al.
54. Income Analysis in the CSRS of the D-N-D Project Farm Resources at Kalikapur	Nazrul Islam, Ranjan Kumar Saha, and Wajed Ali Saha
55. Partial Budget Analysis of Fertilizer and Cropping Pattern Trials at Hathazari CSRS	Rezaul Karim and S. M. Elias
56. Income Analysis of Rural Households in FSRS	S. S. Choudhury, et al.
57. Analysis of Temporal Income and Expenditure of Farmers in Jessore CSRS	Mustafizur Rahman
58. Fertilizer Price Analysis, FSRS, Jamalpur	Shamsul Alam
59. Farm Income and Expenditure Behavior, Rabi Season	Ranjan Kumar Saha and Wahed Ali Saha

6.7. Publications (continued).
6.7.4. Economics and Social Science.

Title	Authors/Editors
60. Analysis of Farm Resources at Janokinathpur FSRS	Baksh, Elahi
61. Agroeconomic Analysis of CSR at Thakurgaon	Siddique, Abu, Asadullah, and A. A.
62. Farm Income and Expenditure at Janokinathpur FSRS	E. Baksh and M. Ahmed
63. A Study of Farm Resources at the FSRS Laherikanda	Shamsul Alam
64. Marketing of T.Aman Seedlings in Selected Areas of Tangaii and Manikganj Districts	Eusuf Harun
65. Partial Budgeting of Traditional and Improved Cropping Patterns, Kalampur	A. K. Azad, M. N. Nabi, M. A. Khan Majlis
66. The Marketing Price of Agricultural Commodities, Janokinathpur FSR Site	Elahi Baksh
67. Farm Income and Expenditure Analysis Laherikanda, Karif-II Season	Shamsul Alam
68. Economic Analysis of Low Cost Technology for Jute Production	G. Murshed, S. Alam
69. Analysis of Farm Income and Expenditure, Janokinathpur, FSRS	E.Baksh, Mustaque Ahmed
70. Labor Utilization Pattern at the FSRS, Janokinathpur	E. Baksh, Mustaque Ahmed
D. Other Papers	
71. An Analysis of the Deep Tubewell Irrigation and Credit Program (DTICP) of CARE, BORO	A. R. Siddiqui and B. A. Greene
72. Changes in Income and Expenditure, North Choto Kalampur FSRS	" "
73. Some Observation on Agricultural Economics Education in Bangladesh	B. A. Greene
74. Estimating Economic Subsistence and Poverty Nutrition Levels from Primary Data. A paper presented at Seminar on Financing the Rural Poor, BAU, Mymensingh	" "
75. Fertilizer Adoption, Hathazari FSRS, 1981-1982. 6th Annual Conference, Bangladesh Ag. Econ. Assoc.	" "

6.7. Publications (continued).
6.7.4. Economics and Social Science.

Title	Authors/Editors
E. Under Consideration	
76. The Effect of Farm Size and Land Type on T.Aman Rice Yield	B. A. Greene
77. Preliminary Analysis of Annual Income for 45 Farm Families	" "
78. Is Farming Systems Research the CART Before the Horse? In Proc. 5th Symposium on FSR/E, Kansas State Univ.	" "
79. Labor Use Standards for Rice, Noakhali District Bangladesh	" "
80. Labor Use Standards for Java, Kalampur FSR site	" "

6.7. Publications.
6.7.5. Crops Research

Title	Authors/Editors
1. Phenotypic Variability and Correlation Studies in Indigenous Chickpea of Bangladesh	M. Q. Islam, A. K. Kaul, and K. Begum
2. Variability for Various Agronomic Characters and Neurotoxin Content in Some Cultivars of Khesari Lathyrus sativus L. in Bangladesh	A. K. Kaul, M. Q. Islam, and K. Begum
3. Screening of Some Bangladesh Cultivars of Rice for Their Consumers Preference and Nutritional Characteristics	M. S. I. Khan and A. K. Kaul
4. South Asian Regional Cooperation Recommendations of the First Meeting of the Working Group on Agriculture	A. K. Kaul
5. "A Strategy for Crop Diversification in Bangladesh" Report by Committee Appointed by the Secretary of the MOA & Forests Division	BARC
6. Pulses in Bangladesh	C. L. L. Gomda and A. K. Kaul
7. Crops Diversification A Means of Employment Generation	A. K. Kaul
8. Crop Diversification for Intensive Cropping	A. K. Kaul and M. M. Rahman
9. Position Paper BARI's Chalna College Project	BARC
10. Barind Development Proposal for MOA	"
11. Research Field Plans for Pulses Project of BARI	"
12. Outline Agroecological and Agroeconomical Survey of Lathyrus Cultivation in Bangladesh	"
13. Position Paper Operational Funds for Agricultural Research	"
14. Working Paper Pulses and Oilseeds	"
15. National Agricultural Research Plan	A. K. Kaul and BARC
16. Oilseeds in Bangladesh	A. K. Kaul, MLDAB, Canada Agricultural Sector Team and MOA
17. Lathyrism in Bangladesh An Agroeconomic Survey	M. A. Hamid, A. K. Kaul, and R. U. Akanda
18. Prospects of Maize in Bangladesh	T. M. Tajul Islam, A. K. Kaul, and FAO/UNDP

6.7. Publications (continued).
6.7.5. Crops Research.

Title	Authors/Editors
19. Status and Prospect of Groundnut Production in Bangladesh	L. J. Reddy and A. K. Kaul
20. Lathyrus and Lathyrism Proceeding of Colloque Lathyrus 1985	BARC
21. Present Status and Recommendations for Future Work for Research in Chickpea, Lentil, and Pigeonpea in Bangladesh	Jagdish Kumar
22. Development Area of the Barind Tract	J. Hunt
23. Options for Dry Land Farming	"
24. Subject Matter Specialist Training Course in Horticulture Technology and Extension Methodology	Andres A. Duncan
25. A Plan for Agronomy and Soil Fertility Management for Rainfed/Dryland Agriculture	Rajat De
26. Pulses Improvement at Bangladesh Agricultural Research Institute Present Status and Program for Future Work	Jagdish Kumar
27. Homestead Gardens for Bangladesh	Jack Gershon
28. Planning a Maize Research and Production Strategy for Bangladesh	Thomas G. Hart
29. Report on Postharvest Technology and Management of Potatoes in Bangladesh	Robert H. Booth

6.7. Publications.
6.7.6. Livestock Research.

Title	Authors/Editors
1. The Integrated Family Farm System for Agriculture, Livestock and Energy Production with the Multipurpose Crops, Multipurpose Animals Ponds with Plants and Animals and a Digester for Control of Both Human and Animal Diseases	J. H. Nielson
2. Increasing Livestock and Energy Production by the Integrated Family Farm System	T. R. Preston
3. Livestock and Poultry Research in Bangladesh	G. H. Wellington, M. Shafiur Rahman
4. A Report of the Training Course on Cattle and Buffalo Development and AI Extension Program	Charan Chatalakhana, D. V. R. Rangneker
5. Report on Training Course Feed and Fodder Production and Utilization in Bangladesh	F. M. Moog, D. V. R. Rangneker
6. Proceedings of Training Course on Feed and Food Production and Utilization in Bangladesh	James R. Dickey, Abdul Hay
7. Status of the Bangladesh Livestock Industry in Relation to Fodder Supply and Consumption of Animal Products	James R. Dickey, Quazi M. Emdadul Haque
8. Bioeconomic Models for Problem Identification A Case Study from Bangladesh	James R. Dickey
9. A Quantative Model of the Livestock Component of a Bangladesh Farm	James R. Dickey, Mirja A. Jalil, and Quazi M. Emdadul Haque
10. Proceeding of Workshop on Commercial Poultry Farming in Bangladesh	Mirza A. Jalil, James R. Dickey, Quazi M. Emdadul Haque, L. R. Siddiqus, and Jahangir Alam

6.7. Publications.
6.7.7. Soil Management.

Title	Authors/Editors
1. Soil Fertility in Bangladesh: A consultancy report (1982)	Sam Portch
2. Second Annual Report: Coordinated Soil Test Crop Response Correlation Studies (1981-1982)	BARC
3. A Plan for a Soil Fertility and Evaluation Program in Bangladesh: A consultancy report (1985)	J. W. Fitts
4. Soil Fertility in Bangladesh: A policy paper (1983)	BARC
5. A Synopsis of Lectures on Soil Fertility Evaluation and Improvement (1983)	J. W. Fitts
6. Fertility Efficiency Research: Paper published in Review of BADC/IFDC Fertilizer Efficiency Research Training Program (1983)	Sam Portch
7. Soil Testing: Paper published in Review of BADC/IFDC Fertilizer Efficiency Research Training Program (1983)	" "
8. Plant Analysis and Tissue Testing: Paper published in Review of BADC/IFDC Fertilizer Efficiency Research Training Program (1983)	" "
9. Abstracts: International Symposium on Soil Test Crop Research Correlation Studies (ISSS, 1984)	BARC
10. Meeting of Commission IV: International Society of Soil Science (ISSS, 1984)	" "
11. Nutrient status of some of the more important agricultural soils of Bangladesh. Proceedings International Symposium on Soil Test Crop Research Correlation Studies. ISSS Commission IV meeting Dhaka.	Sam Portch and M. S. Islam
12. Soil Fertility Analytical Services in Bangladesh: A consultancy report (1984)	Arvel Hunter
13. Potential for Mimimum Tillage in Bangladesh: A consultancy report (1984)	Robert Blevins
14. Potential for Maximum Yield Research in Bangladesh: A consultancy report (1984)	Larry Sanders
15. Recommendations: To the Commission IV meeting ('SSS, 1984)	BARC
16. Biological Nitrogen Fixation: A training manual (1984)	Various authors/BARC
17. How to Take a Soil Sample (Poster with text) (1985)	BARC

6.7. Publications (continued).
6.7.7. Soil Management.

Title	Authors/Editors
18. Information sheet (to accompany soil sample) (1985)	BARI
19. Analytical Result Report Sheet (one for soil and one for plant analysis) (1985)	" "
20. Analytical Chemistry, Instrumentation, and Maintenance: A Training Manual and Aid (1985)	Len Mattick and Sam Portch
21. Third Annual Report: Coordinated Soil Test Crop Response Correlation Studies (1982-1983) (1985)	BARC
22. 1985 Fertilizer Recommendation Guide for Most Bangladesh Crops (1985)	" "
23. Proceedings of the Inter Congress Meeting of Commission IV, ISSS, Soil Test Crop Response Correlation Studies (BARC, 1985)	M. A. Mannan, A. K. M. Habibullah,
24. Clay Mineralogy of Some Soils of Bangladesh: A consultancy report (1985)	Joe White
25. Legume Inoculation: A consultancy report (1985)	Robert Davis
26. Minimum Tillage Research Project and Training: A consultancy report (1985)	Lloyd Murdock
27. Proceedings of the International Symposium on Potassium in Agricultural Soils (BARC, 1985)	A. K. M. Habibullah, Ken Nielsen, and Sam Portch
28. Soil Fertility Evaluation and Improvement in Bangladesh, Better Crops International (1985)	M. S. Islam and Sam Portch
29. Sulphur: A major constraint to high yields in Bangladesh, Sulphur in Agriculture (1986)	Sam Portch and M. S. Islam
30. Soil Fertility Analytical Services and Research for Bangladesh: A consultancy report (1986)	Arvel Hunter
31. Determining potassium requirements for various crops in Bangladesh, Proceedings ICMFUS meeting, China (1986)	M. S. Islam, Ken Nielsen, and Sam Portch
32. Soil fertility evaluation and improvement in Bangladesh: A case study, Proceedings ICMFUS meeting, China (1986)	Sam Portch and M. S. Islam
33. Proceedings of the International Symposium on Sulphur in Agricultural Soils (1986)	Sam Portch and Sk. G. Hussain
34. Sulphur in Bangladesh Soils: A status report, Proceedings International Symposium on Sulphur, FADINAP Bangkok (1987)	Sam Portch and M. S. Islam

6.7. Publications (continued).
6.7.7. Soil Management.

Title	Authors/Editors
35. Soil Conservation for Bangladesh: A consultancy report (1987)	James Box
36. Physical Aspects of Soils Management in Bangladesh: A consultancy report (1987)	S. S. Prihar
37. Proceedings of the International Symposium on Minimum Tillage (BARC, 1987)	Sam Portch, Z. Karim, and
38. Proceedings of the Workshop on Clay Mineraology (1987)	Sam Portch and Z. Karim
39. Bangladesh Crops Need Sulphur (a brochure) (1987)	BARC
40. Reproduced 300 copies each (with permission) of Technical Bulletins 3, 4, 5, 6, and 7 of the International Soil Fertility Evaluation and Improvement Program of North Carolina State University	Various
41. Reproduced 200 copies each (with permission) of Soil Fertility Manual (93 pages) and Maximum Economic Yield Manual (144 pages) of Potash and Phosphate Institute	Various
42. Fertilizer Nitrogen Deep Placement for Rice, Proceedings of the Technical Session (July 1985)	BARC

6.7. Publications.
6.7.8. Irrigation and Water Management.

Title	Authors/Editors
1. Irrigation and Water Management	S. Levine
2. Final Report of Consultancy	Max Lowder Mick
3. First Annual Report Coordinated Irrigation and Water Management	BARC
4. Proposed Activity for IADS Water Management Extension at BARC	David Gisselquist
5. Proposed Water Management Activities Report for the BARC/IDAD Agricultural Engineer	Loyd Johnson
6. Net irrigation requirements of rice and evapotranspiration of wheat and potato for different locations of Bangladesh	Z. Karim and N. A. Akhand
7. Minor Irrigation Development in Bangladesh	Martin Hanratty
8. Observations on Water Management Issues in Bangladesh	Loyd Johnson
9. Collection of different types of manually operated pumps available in the country and evaluation of their performance in order to select the best available design to carry further modification if necessary to improve performance	Abdul Ghani, Taufiqul Islam, and Humayun Khondoker
10. Economic aspects of minor pump irrigation development in Bangladesh	Leslie E. Small
11. Report of 3-week study in Bangladesh for the Cornell University/USAID Water Management Systems Project	J. K. Campbeu
12. Water Management Workshop	Gil Levine
13. Second Annual Report, Coordinated Irrigation and Water Management Studies (1981-1982)	BARC
14. Review of Irrigation Water Management Program at Bangladesh Agricultural University, Mymensingh	Florence McCarthy, Ramchand Dad, Duane Johnson, and Michael Walter
15. Groundwater Development in Bangladesh Institutionalizing: A strategy	George Radosevitch
16. Priorities for Research in Irrigation and Water Management	BARC
17. Options in Powering Irrigation Equipment for Tubewells and Low Lift Pumps in Bangladesh	Richard R. Howes
18. The demand for tubewell equipment in relation to groundwater availability in Bangladesh	Gerard J. Gill

6.7. Publications (continued).
6.7.8. Irrigation and Water Management.

Title	Authors/Editors
19. A framework for economic research on water management in Bangladesh	Jack Kellar, Mark Rosegrant, James Rovmasset, Thomas Weaver
20. Water Law Bibliography for Bangladesh	George E. Radoslvitch
21. Economic and Technical Operation of Deep Tubewells in Bangladesh	Sam H. Johnson III
22. 1983 Internal Review of BARC's Irrigation Water Management Research Program	S. D. Chowdhury, A. Hamid, and Arshad Ali
23. Irrigation and Water Management External Evaluation Report	Slack and McConnen
24. Equity Issues in Irrigation in Bangladesh, A Comparative Discussion of Technologies, Organization and Support Services	Jan Emmert
25. Command area development for minor irrigation	S. D. Chowdhury and David Gisselquist
26. Preliminary list of entries for forthcoming BARC Annotated Bibliography on Irrigation and Water Management in Bangladesh	Ekramui Ahsan, Musharraf Hossain, Altaf Hossain, and David Gisselquist
27. Debiganj Irrigation System Master Plan	Bill Carson
28. A suggested approach to model use and development	Richard R. Howes
29. Economic and Technical Criteria for Location of Deep and Shallow Tubewells	Sam H. Johnson III
30. Data Base Management at BARC Application for Documentation and Administration	Jane S. Johnson
31. Use of Remote Sensing for Agricultural Research in Bangladesh	Kevin Dalsted
32. Irrigation Water Production Functions Report on Training Course	George Hargreaves
33. Diagnostic Analysis of Four Irrigation Systems in Bogra	Z. Karim, M. Idris, and R. Hoque
34. BARC Third Annual Report Coordinated Irrigation and Water Management Studies (1982-1983)	BARC
35. 1985 Internal Evaluation of the WMP	S. M. Arshad Ali
36. Measuring Devices for Irrigation Systems in Bangladesh	John A. Replogle

6.7. Publications (continued).
6.7.8. Irrigation and Water Management.

Title	Authors/Editors
37. Evaluation of Water Well Technology in Bangladesh	Brij M. Sahni
38. Irrigation Methods for Upland Crops	Honorato L. Angeles
39. Manual and Animal Powered Pumps for Irrigation	David Gisselquist
40. Groundwater Investigations Report on a Training Course	Calvin G. Clyde
41. Assessment of Saline Soils Research	Ghulam R. Sandhu
42. Remote Sensing Techniques	Kevin Dalsted
43. Parameters of Performance of Minor Irrigation in Bangladesh	Mozammei Hossain
44. Reports on a Workshop on Methodologies to Evaluate the Performance of Irrigation Systems	BARC/Winrock International
45. Proceedings of a Workshop on Low Water Using Cropping Pattern for Irrigation Agriculture	BARC
46. Pump Irrigation in Bangladesh: A Short Awareness Course	" "
47. Fourth Annual Report Coordinated Irrigation and Water Management Studies (1983-1984)	" "
48. Conjunctive Use of Surface and Groundwater for Irrigation in Bangladesh	Michael
49. Irrigation Scheduling State of the Art	Wymore
50. Groundwater Irrigation Report on a Training Course	Calvin Clyde and Tim Decker
51. Systems Approach to Planning and Managing Water Resource Project	John W. Labadie
52. Status of Recommendations Made by Consultants to the Irrigation and Water Management	Carlos Garces and Kh. A. Haq
53. Fifth Annual Report Coordinated Irrigation and Water Management Studies (1984-1985)	BARC
54. Measuring and Control Devices for Irrigation and Drainage Systems in Bangladesh	John A. Replogle
55. Course on Groundwater Investigation	Calvin G. Clyde and Tim L. Decker
56. Role of Bonds for Irrigation in Farming Systems in Bangladesh	Michael F. Walter

6.7. Publications (continued).
6.7.8. Irrigation and Water Management.

Title	Authors/Editors
57. Management, Quantity, and Quality of Groundwater in Bangladesh	Steenhuis
58. Assessment of Research and Pilot Demonstration on Water Distribution Systems and Crop Water Requirements in Bangladesh	A. M. Michael
59. Crop Water Requirements	George H. Hargreaves

6.7. Publications.
6.7.9. Pest Management.

Title	Authors/Editors
1. Towards an Insecticide Toxicology Laboratory at the BARI	E. Magallona
2. Bangladesh Integrated Pest Management: Report on a Training Workshop	L. A. Fielder, E. H. Glass, and H. D. Thurston
3. Evaluation and Design of Research Programs for Insect Pests of Cotton Pulses and Potato	R. A. Van and Steenwyk
4. Plant Disease Diagnostic Training in Bangladesh and Recommendations for the Establishment and Administration of Plant Disease Clinics	R. L. Wick
5. Pest Monitoring and Surveillance in Bangladesh	Charles L. Cole and Wendell C. Horne
6. Research Evaluation and Planning for a Five Year Integrated Pest Management for Bangladesh	Marvin K. Harris
7. Banana Tissue Culture Techniques and Applications	Alice C. Woods
8. Further Developments on Insecticide Toxicology	E. Magallona

6.7. Publications.
6.7.10. Potato Reports, CIP.

Title	Authors/Editors
1. Bangladesh Potato Improvement Program Progress Report (1983-1984)	L. C. Sikka
2. Bangladesh Potato Improvement Program Progress Report (1984-1985)	L. C. Sikka
3. Bangladesh Potato Processing Consultancy visit (1985)	Peter J. Keane

7. BUDGETS

Table 7.1. Budget comparison statement by line items.

For the period from 1 July 1981 to 31 January 1988

Category	Contract Budget (US dollars)	Actual Costs (US dollars)	Percent of Budget (%)
Technical Assistance	9,668,946.00	9,567,584.71	98.95
Local Support	1,436,297.00	1,427,217.80	99.37
Overseas Training	2,018,662.00	2,001,405.59	99.15
In-country Training	1,184,074.00	1,155,626.37	97.60
Contract Research & Evaluation	847,511.00	818.930.32	96.63
Commodities & Construction	2,956,080.00	2,885,898.14	97.63
WI HQ Staff & Expenses	493,110.00	497,726.60	100.94
WI Management Fee	2,979,320.00	2,943,732.31	98.81
Procurement Fee	191,000.00	186,820.91	97.81
Pre-Contract Expenses	25,000.00	25,000.00	0.00
Total	21,800,000.00	21,509,942.75	98.67
Billing Adjustments/Reductions		(24,447.24)	
Net Cumulative Total Claimed		21,485,495.51	98.56

7.2. Expenditure statement by program areas.

For the period from 1 July 1981 to January 1988
(All figures in U.S. dollars)

Program	Technical Assistance	Overseas Training	In-Country Training	Contract Res./Eval.	Commodities/ Construction	Total
Research Management	1,670,453.81	402,859.67	258,000.86	28,654.43	710,121.35	3,070,090.12
Technical Support Ser.	1,276,677.03	75,987.97	72,330.90	230.19	672,888.27	2,098,114.36
Farming Sys. Research	1,621,487.25	114,102.59	15,424.65	52,837.65	191,073.14	1,994,925.28
Econ./Social Science	756,629.14	142,628.20	79,562.31	163,546.98	70,566.26	1,212,932.89
Crop Research	1,318,990.41	457,449.03	100,123.45	197,994.79	342,958.95	2,417,516.63
Livestock Research	448,203.60	58,363.67	49,202.06	11,776.27	38,516.24	606,061.84
Soil Management	652,083.31	302,046.21	143,605.84	57,314.66	300,352.45	1,455,402.47
Water Management	1,211,997.66	290,237.50	382,425.63	306,575.35	249,425.30	2,440,661.44
Pest Management	541,021.00	157,730.75	54,950.67	0.00	309,996.18	1,063,698.60
Total	9,497,543.21*	2,001,405.59	1,155,626.37	818,930.32	2,885,898.14	16,359,403.63

*This total does not include $70,041.50 for fees and travel related to the Cornell University sub-contract.

Winrock International

Project Profile

Bangladesh Agricultural Research Project — Phase II

The Country

Official Name People's Republic of Bangladesh

People ***Population:*** 99.5 million (1984)
Annual growth rate: 2.5%
Life expectancy: 45 years ***Average age:*** 16 years
Population density: 1,740 per sq mi (one of the world's most densely populated countries)
Distribution: Urban 15%, rural 85%
Ethnic groups: Bengali 98%, Bihari 2%, tribal groups less than 1%
Religions: Muslim 83%; Hindu 16%; Christian, Buddhist, and other 1%
Languages: Bangla (official; also known as Bengali), English (widely used in business, academia, science, and government)
Literacy rate: 25%
Education: Primary school 65%, secondary school 25%
Daily newspaper circulation: 6 per 1,000 persons

Geography ***Area:*** 55,813 sq mi (143,998 sq km) (slightly larger than the state of Arkansas)
Location: In south Asia on the north bend of the Bay of Bengal; surrounded on the north, west, and east by India, and on the southeast by Burma
Cities: Capital — Dhaka (formerly Dacca) 3.5 million, Chittagong 1.4 million, Khulna 623,000, Narayanganj 196,000

The Project

Official Name Agricultural Research Project — Phase II (ARP-II)

Term June 1981 to June 1986 (extended to June 1987 with original funding)

Funding Agency U.S. Agency for International Development (USAID) grant administered through host-country contract by the Bangladesh Agricultural Research Council (BARC)

Amount US$21.8 million

National Cooperating Agency Bangladesh Agricultural Research Council, Farm Gate, Dhaka, Bangladesh

Subcontractor Cornell University, Ithaca, New York (provide short-term consultants and manage the placing and monitoring of graduate students in U.S. institutions).

Summary A 6-year, USAID-funded, host-country contract with BARC to increase the effectiveness of agricultural research necessary for developing appropriate technologies for Bangladesh farmers by 1) building capabilities to move agricultural research activities into farmers' fields where production problems can be identified and solutions tested, 2) building strong, responsive, core-discipline research programs to develop the new technologies that can address these problems, and 3) linking different agricultural institutions into a research system to achieve the country's agricultural development objectives of greater food production through more productive use of land and water.

Objectives To increase the effectiveness of the agricultural system to develop and transfer appropriate technologies to Bangladesh farmers. The project is to strengthen BARC and the Bangladesh Agricultural Research Institute (BARI), but also is concerned with improving the capabilities of other institutes linked with BARC. The objectives will be achieved by development of core research programs within the farming systems framework. The project provides support to improve research planning and management, facilities, and services, as well as for growth of research programs concerned with crop improvement, soil and water management, pest control, and farming systems. The support includes technical assistance, research equipment and commodities, training, and funds for high-priority research.

Project Components ***Technical assistance:*** 1) 73 person-years of long-term technical assistance in 18 subject areas, and 9 person-years of short-term consultancies. 2) Management of the procurement program. 3) Supervision of in-service and advanced training. 4) "Contract research" funds for experimentation conducted by Bangladesh institutions and researchers.
Training: US$2.3 million for 82 person-years of U.S. and third-country training, plus in-country training of about 2,000 research and extension

Terrain: Flat alluvial plain formed by the deltas of the Ganges and Brahmaputra rivers; marshy along the coast. Hills only in the extreme southeast (Chittagong Hill Tracts) and northeast (Sylhet area).
Climate: Subtropical monsoon. Average rainfall: about 60 inches, ranging from 47 inches in the northwest to over 100 inches in the northeast (one of the rainiest areas of the world). Subject to frequent cyclonic storms that form in the Bay of Bengal. Hot, humid rainy season from March to October or November. Much of the country is submerged or subject to flooding in the summer rainy season (July through September).

Government ***Type:*** Martial law
Independence: 1971
Principal agencies concerned with agriculture: Ministry of Agriculture and Forests, Ministry of Fisheries and Livestock, and Ministry of Industries and Commerce. Many agricultural agencies are semiautonomous organizations operating under government ministries, such as most of the agricultural research institutes.

Economy ***Gross domestic product:*** US$11.2 billion (1982-1983)
Annual growth rate: 3.7%
Per capita income: US$119 (one of the world's lowest)
Natural resources: Natural gas, inexpensive labor
Chief industries: Cement, jute, textiles, fertilizer, petroleum products
Chief crops: Jute (most of the world output), rice, tea, sugar, wheat

Agriculture 55% of GDP
Land area: 35.3 million acres, of which 22.5 million acres are planted to at least one crop annually; cropping intensity is 153%. Little new land is available for agriculture; some area currently used for agriculture and inland fisheries is being claimed for urbanization and industrial uses.
Employment: 85% agricultural
Nutritional level: 1,943 calories per person per day (1981-1982)
Food self-sufficiency: Can be self-sufficient only in years of good growing conditions; usually dependent on imports to meet basic food needs, notably cereal crops.
Foodgrain production: 15.1 million tons (1983)

personnel, and for regional workshops, study tours, farmer field days, and farmer-level training.
Commodities, construction, and other: US$2.5 million for equipment, supplies, minor construction, and vehicles.

Background ARP-II is the second phase of USAID-funded support for agricultural research in Bangladesh. The national system consists of a dozen semiautonomous institutes and autonomous universities conducting research on food and cash crops, livestock, forestry, and fisheries. Another dozen agencies and educational institutions are involved in agricultural research to a lesser extent. ARP-I was a 3-year grant of US$4,391,800 in 1979-1981 that focused on wheat, food legumes, oilseeds, and vegetables, which are within the mandate of BARI (the major crops of rice and jute are the responsibilities of other institutions). The project also sought to strengthen BARC as the research-coordinating body of Bangladesh, and to construct administrative and research facilities at BARI headquarters at Joydebpur and the Regional Agricultural Research Station at Ishurdi. There were technical assistance, training, and commodity procurement components. The International Agricultural Development Service (IADS) — a predecessor to Winrock — was the contractor.

In 1980, an evaluation team reviewed the USAID and World Bank projects in agricultural research. Their recommendations led to ARP-II. IADS was awarded the contract and operations began in mid-1981.

Both ARP-I and -II have been guided by the food self-sufficiency goals of the Government of Bangladesh's Second and Third Five Year Plans. IADS and now Winrock have maintained an expatriate staff of up to 23 persons in Bangladesh for this project. The current Winrock staff level (August 1986) is 17 expatriates who are from seven countries. Each specialist works with a counterpart Bangladesh administrator or team of scientists. Seven specialists are at BARC, and the others are assigned to BARI (though all have counterparts at BARC). The Winrock personnel are considered to belong to the BARC and BARI staffs.

Highlights These are some of the contributions of ARP-II:

- The concept of farming systems research (FSR) has been introduced and institutionalized within BARC and several of the institutes (BARI, Bangladesh Rice Research Institute, Bangladesh Jute Research Institute, Bangladesh Agricultural University, and Sugarcane Research and Training Institute). A national coordinating committee is in place to oversee farming systems research and on-farm testing throughout the country.

- Regular field days have been conducted at the four Regional Agricultural Research Stations of BARI and the FSR cropping sites.

- Training in preparing research plans and then conducting the experiments, and instruction in using standardized methodology for analyzing the data, have led to improvement in the quality of research conducted in the national system and in the administration of the work.

- The contract research funds have been a stimulus to projects that could not be funded through regular budgets. Management of the program has been strengthened. Publications were produced on how to prepare the proposals, and procedures were simplified for using these funds. The grants are widely distributed through the research system, and Winrock specialists assist with monitoring and evaluating the work. Nevertheless, ARP-II contract research grants are unpopular with Bangladesh scientists because of the lack of flexibility in using USAID funding.

• Computers became a part of the Bangladesh research system in 1984. Winrock provided consultants to advise BARC on how to use this technology and to train researchers to use the new equipment in their work. Software programs have been introduced to improve research operations and project administration, ranging from designing field plots to cataloging library acquisitions.

• A national soil fertility evaluation and improvement program is increasing the productivity of one of the country's basic resources. A central analytical laboratory was designed and installed at BARI to provide soil analysis and other testing as a nationwide service. To support this work there has been extensive training in sampling procedures and interpretation of results, publication of fertilizer recommendations, and international meetings and courses.

• A national livestock research institute was created in 1983 to overcome constraints in this important but often overlooked segment of Bangladesh agriculture. Winrock has provided leadership in identifying priorities and researchable issues for improving livestock production and use.

• Insects and plant diseases cause major food-production losses in Bangladesh, but there has been surprisingly little research to develop adequate control procedures. Crop-protection research has been strengthened throughout the country by Winrock specialists. Much-needed facilities have been planned and built, such as a headhouse and screenhouse to be used by entomologists and plant pathologists at the BARI headquarters. A toxicology research laboratory has been renovated to better serve scientists.

• Bangladesh has ample water supplies during most of the year, but this varies from the extremes of heavy flooding and erosion in the summer months to a rainless dry season in the December-March period. Irrigation is becoming a major factor in modernizing Bangladesh agriculture; thus, improving the use of water resources is an important goal of ARP-II. This project has helped in the design of irrigation systems, operating procedures, and legal guidelines to meet the country's unique needs.

• ARP-II has increased the supply of scientific literature in the research libraries, and improved communication has been initiated among the nation's 1,600 agricultural researchers and managers with a regular BARC newsletter. Many publications have been issued as part of the project's activities, including conference proceedings, research reports and recommendations, and consultants' reports.

• Winrock has encouraged special events so national decision-makers and other opinion leaders will know about the benefits of agricultural research. Foremost among these have been the National Symposiums on Agricultural Research in 1983 and 1986. International symposiums have been held to enhance the Bangladesh image in the region and to focus national attention on the value of agricultural research. Several general information and scientific publications have been produced to describe BARC and other components of the research system to key national and international audiences. Cooperative training ventures with international agricultural research centers have improved research management capabilities in Bangladesh and neighboring countries.

• BARC's national leadership and coordination role has been strengthened by the preparation of the National Agricultural Research Plan, 1984-1989. It is being revised and updated in 1986 under Winrock guidance and leadership. The plan describes goals, objectives, projects, and priorities for the full range of agricultural research in Bangladesh, and complements the national goals set out in the Third Five Year Plan.

• Every phase of ARP-II includes a training component to build Bangladesh's ability to manage and conduct research. Dozens of

Winrock International specialists in the Bangladesh ARP-II encourage on-farm research. Top: Dr. Travis Everett (right) and a BARI entomologist check insect populations in field trials. Center: Dr. R.M. Mallick (left) and Dr. A.H. Manzano (center) visit with a Bangladesh farmer about the livestock component of his farming system. Bottom: Dr. A.K. Kaul (center) gets information from farmers from which the country's agricultural research priorities will be developed.

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researchers and administrators have been sent abroad to seek advanced degrees; others have taken part in specialized short-term training and have attended scientific meetings and workshops. There also is extensive in-country training, from graduate study to in-service training to sabbatical programs to farmer field days.

- A broad range of equipment has been purchased through Winrock, shipped to Bangladesh, and installed in BARC and other research institutions. Many scientists now have available the specialized instrumentation needed for their laboratory and analytical work and their field experimentation. This is complemented by modern office equipment, which is needed to improve the level of administrative and financial services.

Winrock Specialists
Project Supervisor/Adviser: Dr. David M. Daugherty
Administration Specialist: Mr. Robert Gustafson
Agricultural Economist: Dr. Brook A. Greene
Agricultural Engineer: Dr. Carlos Garces
Associate Production Agronomists: Dr. R.N. Mallick (assigned to Regional Agricultural Research Station, BARI, Ishurdi); Dr. Nadarajah Vignarajah (assigned to Regional Agricultural Research Station, BARI, Jamalpur); and Mr. Leopoldo M. Villegas (assigned to Regional Agricultural Research Station, BARI, Jessore)
Crops Specialist: Dr. A.K. Kaul
Entomologist: Dr. Travis R. Everett
Horticultural Specialist: Dr. Deran Markarian
Information Specialist: Mr. Peter Thorpe
Instrumentation and Maintenance Specialist: Dr. Leonard Mattick
Livestock Specialist: Dr. James R. Dickey
Production Agronomist: Mr. Eduardo R. Perdon
Soil Fertility Specialist: Dr. Sam Portch
Water Management Specialist: Dr. Rogelio C. Lazaro

Winrock Contacts
Main Office: BARC Complex, Farm Gate, Dhaka-15, Bangladesh
Mail address: P.O. Box 6083, Gulshan, Dhaka-12, Bangladesh
Telephones: 314361, 600787
Telex: 642401 SHER BJ WINROCK
Cable: AGRESEARCH DACCA (BANGLADESH)
Administrative Office: Mr. Mezbahuddin Ahmed, General Manager

Home Office Coordinator: Dr. A. Colin McClung
Host-country Contract Representative: Dr. Ekramul Ahsan, Chairman-in-Charge, Bangladesh Agricultural Research Council

Funding Agency Representatives, U.S. Agency for International Development, Dhaka
Food and Agriculture Officer: Dr. H. Patrick Peterson
Project Manager: Mr. Kevin Rushing

Related Projects in Bangladesh Funded by USAID: Vertebrate pest project at BARI; research support for the Bangladesh Rice Research Institute.

Former Winrock Projects in Bangladesh: Human resources development in the social sciences, completed June 1986; potato research project (managed on behalf of the International Potato Center), completed June 1986.

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Winrock International Institute for Agricultural Development, Petit Jean Mountain, Morrilton, Arkansas 72110, U.S.A.