PD-ABD-491
ISN

INTERNATIONAL CONSULTING DIVISION

CHEMONICS

FINAL REPORT

BRRI/IRRI PROJECT EVALUATION

Project No. 388-0051
IQC Contract No. PDC-1406-00-0033-00
Delivery Order No. 19

Prepared by:

R. Karim
M. A. Mannan
J.W. Tanner
C. F. Fritsch (Team Leader)

Prepared for:

U.S. Agency for International Development
Canadian International Development Agency
Dhaka, Bangladesh

December 1, 1991

2000 M St., N.W.
Suite 200
Washington, D.C. 20036

Tel: (202) 466-5340 or 293-1176
Fax: (202) 331-8202
ITT Telex: 1440361 CHNC UT

TABLE OF CONTENTS

		Page
LIST OF ACRONYMS		i
ACKNOWLEDGEMENTS		iii
SUMMARY OF FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS		v
SECTION I	ESTABLISHMENT OF BRRI AND THE IMPORTANCE OF RICE IN BANGLADESHI SOCIETY	1
SECTION II	IRRI/BRRI PROJECT ACTIVITIES LEADING TO DEVELOPMENT OF IMPROVED RICE VARIETIES	3
	A. Background of Breeding Rice in Bangladesh	3
	B. Contribution of Rice Breeding to Bangladesh	3
	C. The Rice Breeding Program	5
	D. The Rice Breeding Program Objectives	6
	E. Servicing the Agroecological Regions	8
	F. Rice in the Future	9
SECTION III	IRRI/BRRI PROJECT ACTIVITIES IN DEVELOPING AND FIELD TESTING ECONOMICALLY APPROPRIATE TECHNOLOGIES	13
	A. Overview of BRRI On-farm Field Activities	13
	B. Defining Farming Systems Research	14
	C. Farming Systems Technologies Tested and Released by BRRI	15
	D. Some Future Directions for Farming Systems Research at BRRI	16
	E. MultiLocational Cropping Trials	17
SECTION IV	BRRI ACTIVITIES ASSISTING AGENCIES AND ORGANIZATION WORKING WITH FARMERS TO INTRODUCE IMPROVED RICE VARIETIES	19
	A. BRRI Collaboration with the Directorate of Agriculture Extension	19
	B. Coordinating Research Activities with Other Organizations Engaged in Technology Transfer Activities	20
	C. Other Technology Transfer Approaches	21

TABLE OF CONTENTS

		Page
SECTION V	MANAGEMENT, FUTURE PROSPECTS, CHANGES AND OPTIONS FOR FUTURE IRRI/BRRI COLLABORATION	23
	A. Research Coordination Mechanisms	23
	B. USAID and CIDA Program Funding Considerations	24
	C. Adequacy of the BRRI Organizational Structure	25
	D. Adequacy of BRRI Research Facilities	26
	E. Personnel Incentive Issues	28
	F. CIDA and USAID Project Management Issues	30
	G. Future Potential Donor Support for BRRI Development	31
ANNEX A	SCOPE OF WORK BRRI/IRRI PROJECT EVALUATION	A-1
ANNEX B	EVALUATION METHODOLOGY	B-1
ANNEX C	HISTORY OF RESEARCH IN BANGLADESH AND DEVELOPMENT OF BANGLADESH RICE RESEARCH INSTITUTE	C-1
ANNEX D	SCHEMATIC OF BRRI PLANT BREEDING PROGRAM	D-1
ANNEX E	BRRI TRAINING PROGRAMS IN TECHNOLOGY TRANSFER	E-1
ANNEX F	NGOs WITH AGRICULTURAL PROGRAMS	F-1
ANNEX G	A CASE STUDY OF BRRI RESEARCH IN KAMALGANJ AND SITIKUND	G-1
ANNEX H	REPORTS AND DOCUMENTS REVIEWED	H-1
ANNEX I	INDIVIDUALS CONTACTED	I-1

LIST OF ACRONYMS

ALART	Advanced Lines Adaptive Research Trials
ARI	Agricultural Research Institute
BADC	Bangladesh Agricultural Development Corporation
BARC	Bangladesh Agricultural Research Council
BARD	Bangladesh Academy for Rural Development
BARI	Bangladesh Agricultural Research Institute
BAU	Bangladesh Agricultural University
BFRI	Bangladesh Forestry Research Institute
BIDS	Bangladesh Insititute for Development Studies
BINA	Bangladesh Institute for Nuclear Agriculture
BJRI	Bangladesh Jute Research Institute
BLRI	Bangladesh Livestock Research Institute
BRAC	Bangladesh Rural Advancement Committee
BRRI	Bangladesh Rice Research Institute
BSRI	Bangladesh Sugar Research Institute
BTRI	Bangladesh Tea Research Institute
BWDB	Bangladesh Water Development Board
CIDA	Canadian International Development Agency
CSR	Cropping Systems Research
DAE	Directorate of Agriculture Extension
FRI	Fisheries Research Institute
FSR	Farming Systems Research
FSR/E	Farming Systems Research and Extension
FVOT	Farmer Variety Observation Trials
GDP	Gross Domestic Product
GOB	Government of Bangladesh
HYV	High-yielding Varieties
ICAR	Indian Council for Agricultural Research
IPSA	Institute of Post Graduate Studies in Agriculture
IRRI	International Rice Research Institute
ISNAR	International Service for National Agricultural Research
LV	Local Variety
MLT	Multilocational Testing
MOU	Memorandum of Understanding
mmt	Million Metric Tons
MV	Modern Variety

NARS	National Agricultural Research System
NGO	Nongovernmental Organization
NSB	National Seed Board
PL 480	United States Public Law 480
PVART	Proposed Variety Adaptive Research Trial
RFS	Rice Farming Systems
SAARC	Southeast Asia Agricultural Research Council
RPT	Rice Production Training
SRDI	Soil Resources Development Institute
SRTI	Sugarcane Research and Training Institute
TA	Technical Assistance
USAID	United States Agency for International Development

ACKNOWLEDGEMENTS

The evaluation team is grateful to all persons listed in annex I who took time to talk with us and share their insights, knowledge, concerns, and suggestions. They have all contributed to the success of the team's efforts.

We wish to extend special thanks to BRRI Director General Dr. A.J.M. Azizul Islam, who on numerous occasions graciously made available his time and the time of his staff for the team's insistent questioning. His insights and discussions provided us with an appreciation of the dedication and commitment to excellence shared by BRRI officers and staff. Dr. Ray Morton and Mr. Habibur Rahman of the USAID Office of Food and Agriculture provided substantive and logistical support for the team throughout our deliberations. Canadian High Commission First Secretary (Development) Mr. Steve Rayfield provided similar support.

Finally we wish to thank Project Support Unit Director Mr. Iqbal Rahman and his administrative and technical staff for cheerfully providing transport, typing, editing, photocopying, and other required logistical support services necessary to complete this evaluation.

SUMMARY OF FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

The Bangladesh Rice Research Institute (BRRI) was established in 1973 to develop new rice technologies for the country. BRRI activities include: (1) conducting research on all aspects of rice; (2) establishing project areas to demonstrate appropriate agricultural technology; and (3) training extension officers and farmers in rice production techniques.

BRRI is a mature institute with some 210 research officers. About 60 percent hold M.Sc. degrees and 14 percent hold Ph.Ds. BRRI breeders have developed 26 modern varieties (MVs) since 1973. MVs account for about 50 percent of the area planted to rice, and produce about 72 percent of total rice harvested. About 93 percent of rice grown during the dry winter boro season is MV. The marginal rate of return on research investment at BRRI has been an astonishing 165 percent.

BRRI follows accepted international standards of plant breeding. New varieties require about 12-14 years from the first cross to the final field test before release as an approved variety. BRRI MVs generally out-perform local varieties (LVs) at low levels of fertilizer use. Present MVs have long straw for feeding draft animals and clearing flood waters common during aus and aman seasons. In the future, higher priority should be given to new, sustainable, disease-resistant and input-efficient high-yield varieties (HYVs) suitable for growth during the irrigated winter boro season. Higher yields during boro can free-up land needed for diversification into other cereals and vegetable crops necessary to improve Bangladesh's nutritional balance. This priority should not come at the expense of existing varietal work now targeted at resource poor, low-input farmers; they continue to need improved MVs developed under the current program.

As a result of BRRI's numerous contributions, and in conjunction with an improved policy framework, Bangladesh is now close to food grain self-sufficiency. This report highlights BRRI's many accomplishments, provides general observations, and makes recommendations to better position Bangladesh for the more difficult challenges it will encounter in the 21st century. Prominent among these challenges is the fact that Bangladesh's population will almost double by 2030 while its arable land base remains constant. Increased food productivity will therefore depend on a more science-based agricultural system that is also more responsive to environmental concerns. Corrective actions taken during the limited period remaining in ongoing U.S. Agency for International Development (USAID) and Canadian International Development Agency (CIDA) projects, as well as Government of Bangladesh (GOB) action, will help set the stage to address these exceedingly complex challenges. More dynamic implementing modalities along the lines described herein and increased political support are necessary for the long-term success of Bangladesh's food grain program.

Below we cite the team's major findings and recommendations. Each is addressed in greater detail in the report sections that follow.

A. BRRI Research Management, IRRI/BRRI Project Management, and Approaches to Future Donor Collaboration

1. BRRI administration and professional staff recognize the importance of strengthening present research planning and management functions. Yet they have been unable to reach a consensus solution on expanding the leadership role of mid-level scientists in project development that permits senior management to retain control over and evaluate the research program.

2. BRRI adopted a task force research management approach in 1974 to promote an interdisciplinary team effort to establish and monitor research programs. It has not been updated to meet the needs of a mature research institute.

3. There is no compelling reason to have a separate task force for regional stations.

4. The headquarters station at Gazipur has better infrastructure and better equipped laboratories than regional stations, and most of the positions are filled with more highly qualified and experienced scientists.

5. The regional stations located at Comilla, Barisal, Rajshahi, Habiganj, Sonagazi, and Bhanga do not have the required manpower; infrastructure development is also quite inadequate, and none has the minimum laboratory facilities needed to test soil pH or salinity.

6. Lack of GOB funding for research operating costs is likely to remain a serious constraint to development of BRRI after June 1993.

7. BRRI has been unable to implement procedures to fully staff regional field stations on a rotational basis.

8. The IRRI/BRRI project supports mini-projects which are planned and implemented with the assistance of the in-country IRRI representative, and which are usually funded with specially targeted moneys from multilateral donor sources.

9. IRRI sponsored in-country training courses can reach a greater number of BRRI scientists at lower cost to the project than complete reliance on overseas in-service training courses.

10. At present IRRI/BRRI project reports are well written and provide useful information on work in progress and work completed. Format changes could improve their usefulness as a management tool.

11. Donor representatives are not always up-to-date on project or BRRI research activities.

Recommendations:

1. CIDA and USAID managers investigate and work with BRRI and the GOB to implement the recommendations in this report. Any future project support from USAID and CIDA should at least provide for research operating funds, including purchase of vehicles, equipment, and buildings. GOB and donor project support should be focused on addressing this report's findings.

2. IRRI field a team of research management specialists similar to the 1974 Russell-Minehart-Freeman team which originally developed the task force approach. The team would provide on-site facilitation of a performance-based BRRI research planning and management approach.

3. An in-country IRRI representative be provided from core funds at the close of the current project to continue the formal liaison between IRRI and BRRI. IRRI/BRRI mini-projects should continue after June 1993, and IRRI should conduct more short-term, in-country training of BRRI scientists and intensify technical and germplasm exchanges.

B. National Agricultural Research System Management

1. The Bangladesh Agricultural Research Council was created in 1973 to coordinate the National Agricultural Research System.

2. Research scientists such as those at BRRI are an invaluable national asset. Their work has made it possible for Bangladesh to become almost self-sufficient in rice production over the past 20 years despite annual population increases averaging greater than 2.5 percent. At present rice consumption levels, production will have to increase to 29 million metric tons (mmt) by 2010 from the current 18.5 mmt if self-sufficiency is to be maintained.

3. BARC does not coordinate closely with member research institutes in developing NARS strategic planning documents. However, member institutes do not systematically develop research priorities as part of the planning documents submitted to BARC.

4. GOB support of research operating costs for ARIs, including BRRI, is about one-fourth of the World Bank standard of one percent of agricultural GDP.

5. BARC administrative and technical management capabilities are weak. Disbursement of research operating funds through BARC is slow and not based on targeted performance indicators. BARC accounting procedures are inefficient.

6. The existing salary and benefit package provided to ARI scientists is unsatisfactory and is the major factor for the recent increase in departures of qualified young professional staff from BRRI for other more rewarding endeavors.

Recommendations:

1. GOB initiate a program to increase funding of operational research costs to the World Bank standard within the next five years.

2. USAID allocate annual PL 480 operational research funds through an institutional mechanism that will help ensure the most efficient use of local currency. Fund disbursement to ARIs might, for example, be administered by a private sector accounting firm. PL 480 fund disbursements to ARIs should be based on an annual review of individual institute research programs using system-wide, objective, performance-based indicators.

3. BARC convene and chair an annual technical program evaluation committee to determine PL 480 funding levels for member institutes. If after a reasonable period the evaluation process is found unsatisfactory, other modalities should be investigated.

4. CIDA funds for operational research expenditures and equipment may be better managed by making allocations directly to research institutes based on ability to meet objective performance targets.

5. GOB act with urgency and dispatch to provide personnel incentives to stem the flow of qualified scientists leaving the NARS.

C. Varietal Development Research

1. Since inception in 1973 BRRI has released 26 new rice varieties.

2. The marginal internal rate of return on rice research investment in Bangladesh has recently been calculated as 165 percent. Put in different terms, each taka invested in rice research has yielded 39 taka in return.

3. The "apparent" decline in yield of MVs since 1970 is most likely due to expanded MV introduction on less favorable areas by farmers unable to afford input application at recommended intervals.

4. Wide annual variability in weather patterns, especially the devastating floods of 1987 and 1988, demonstrates vulnerability of the country's agriculture to natural calamities and the difficulty in projecting production.

5. Policy changes in recent years enabled private sector dealers to more easily import diesel motors, commercial fertilizers, pesticides, and power tillers. This contributed to the 14 percent increase in rice production in 1989-90 over the previous year.

6. The current process for licensing approved rice varieties through the NSB is cumbersome and delays distribution of certified seed to farmers.

7. The BRRI breeding program incorporates a conscious decision to develop MVs with taller straw to meet farmer needs for fuel and cattle fodder. Thus, the germplasm base may not be quite as narrow as that of some other countries.

8. Recently, Bangladesh was divided into 30 distinct agroecological regions. It is not the intent, nor would it be practical, for BRRI to direct specific research programs to all 30 zones.

9. IRRI has recently defined five major ecosystems as a basis for conducting research. The four major ecosystems identified by BRRI researchers describe the same ecosystems identified by IRRI.

10. Irrigation is essential to increase boro crop yields, and modest amounts of irrigation in the early growth stages of aus or the late stages of aman could significantly increase yield of these crops.

11. A major increase in boro yield could reduce land requirements and increase likelihood of successful expansion in crop diversification.

Recommendations:

1. BRRI plant scientists adopt a priority program to develop sustainable, disease-resistant and input-efficient HYV boro varieties to meet anticipated nutritional needs of projected population growth and release land for needed crop diversification.

2. The present NSB seed registration procedures be streamlined by accepting results from the regional yield trials conducted by BRRI as the basis for registration. Further on-farm testing after registration can identify areas where new varieties are particularly well adapted.

D. Farming Systems Research

1. The BRRI Rice Farming Systems Research Division pioneered site-oriented systems research in Bangladesh. Individual BRRI FSR sites are usually maintained for two to three years, after which research activities are discontinued in favor of a new site. This methodology promotes development of technology packages reflecting on-farm research results conducted over a wide geographic area. It precludes the need to install expensive infrastructure and permanent professional staff at the research site.

2. Since the early 1980s, donor-supported FSR on-farm research activities have been broadened by introducing new technology transfer activities beyond the traditional crop-based orientation of BRRI. The expanded programs require expensive infrastructure and permanent site-specific professional staffing. Sites tend to become mini-research stations, managed by scientists rather than farmers. These activities have increased the cost of on-farm research and make the research nature of activities more tenuous and confusing.

3. The narrower crop and livestock FSR approach used by BRRI is best suited to the technical orientation of the institute and is less costly than fixed-site FSR approaches.

4. Major weaknesses in FSR research now conducted by BRRI include: a) lack of systematic economic and financial analysis to assess commercial viability of whole farm systems analyzed under farmer management conditions; and b) lack of on-farm testing of improved postharvest rice technologies targeted toward women.

Recommendations:

1. Future FSR strategies in Bangladesh promote less costly on-farm research activities not dependent on fixed infrastructure and permanent site-specific field staff.

2. BRRI develop an action plan to integrate whole farm production economic analysis into FSR research design and analysis procedures.

3. BRRI actively develop and test, within its FSR strategy, postharvest rice-based technologies to meet the needs of rural women working in small village homestead sites.

4. BRRI develop an action plan to introduce women-based postharvest rice technology and stronger private sector technical expertise into FSR demonstration and field day activities.

5. A NARS-wide, program-oriented master plan be prepared for conducting on-farm research and demonstration activities to more efficiently allocate resources and responsibilities promoting improved complementarity and collaboration among ARIs.

E. Technology Transfer Systems

1. There is a major gap between technology available and technology adopted by farmers. This indicates a serious problem in technology transfer.

2. BRRI has close working relationships with the Directorate of Agricultural Extension (DAE) and has pioneered close working relationships with NGOs in the past.

3. A Memorandum of Understanding (MOU), updated at regular intervals, is used to formalize working relationships between BRRI and the DAE regarding varietal improvement testing. However, the MOU does not address joint BRRI/DAE collaboration in: a) selecting FSR sites; b) defining collaborative implementation of research activities on these sites; c) expanding DAE activity in developing outreach programs; or d) using FSR sites for extension demonstration purposes.

4. BRRI officers provide training to DAE officers at regular intervals and to NGO staff at less frequent intervals. Farmer field days are not conducted as an ongoing part of the FSR or the varietal improvement testing program.

5. Numerous local and expatriate-led NGOs have developed effective technology transfer programs and/or outreach activities across a broad spectrum of agricultural activities.

6. Donor agencies such as USAID and CIDA are becoming increasingly receptive to supporting joint public/private interface to promote a more cost-effective technology transfer capability.

7. In the early 1980s, BRRI achieved widespread adoption of BR-11 within three years after introduction by direct release of foundation seed to farmers utilizing the outreach capabilities of the extension system.

8. Technology transfer activities can be improved by vertically integrating the complementary functions of BRRI and private sector outreach organizations.

Recommendations:

1. BRRI expand the agricultural economics content of practical short courses given to extension staff and NGO representatives operating in the local-level agricultural sector, using a "training of trainers" approach.

2. Future MOUs between BRRI and the DAE explicitly provide for BRRI/DAE collaboration in all phases of farming systems research and demonstration work.

3. BRRI include regular farmer field days with demonstrations as part of the expanded FSR technology transfer activities to promote medium-level technology transfer and gain first hand farmer feedback.

4. The BRRI RFS Division enter into collaborative technology transfer working arrangements with appropriate NGOs using the MOU as the formalizing instrument. Donor or other funding agencies should be sought to facilitate these agreements.

5. BRRI initiate a quarterly newsletter targeted toward the extension, agricultural NGO, and commercial farming communities to disseminate knowledge gained from field-level variety development, multilocational testing (MLT) and FSR trials as it is developed. The emphasis is on promoting promising advanced varieties and field technologies before becoming officially "approved." Donor funding should be sought to support initially the newsletter.

SECTION I
ESTABLISHMENT OF BRRI AND THE IMPORTANCE OF RICE IN BANGLADESHI SOCIETY

Important new rice research activities in Bangladesh began in the early 1960s. ARI scientists started temporary rice crop breeding work on lands of the Savar Dairy Farm. After establishment of the International Rice Research Institute in 1963, the then Government of East Pakistan sanctioned a scheme of Accelerated Rice Research (1966), and research continued with exotic progeny and pedigree lines supplied by IRRI. The East Pakistan Rice Research Institute was established in 1970, renamed the Bangladesh Rice Research Institute after independence. In 1973, BRRI was formally approved by Act X of Parliament. BRRI headquarters is situated at Gazipur (formerly Joydebpur) on 66 ha of land adjacent to the Bangladesh Agricultural Research Institute (BARI).

Rice is the staple food of the Bangladeshi population and is the major energy source. Rice covers 80 percent of the total cropped areas—about 10.4 million ha—and is the only source of cash income for many small scale farmers. At present, 60 percent of the average caloric requirement of the population is met with rice.

Although Bangladesh is now close to food grain self-sufficiency, the annual food deficit ranges from 1.5 to 2 mmt. During the 1989 and 1990 growing seasons total rice production reached 18.5 mmt. If population growth is not checked it may reach over 175 millions within the next 20 years, requiring production of some 29 mmt from the same limited cultivated area. In the absence of more arable land, this will be possible only through continued dedication to improving water management and to basic rice research and technology adoption, a most daunting task.

BRRI was established to develop new technologies to meet this challenge. The major objectives of BRRI are to: (1) conduct research on all aspects of rice; (2) establish project areas to demonstrate appropriate agricultural technology; and (3) train extension officers and farmers in improved rice production techniques. Review of the IRRI/BRRI project takes these activities into consideration.

SECTION II
IRRI/BRRI PROJECT ACTIVITIES LEADING TO DEVELOPMENT OF IMPROVED RICE VARIETIES

A. Background of Breeding Rice in Bangladesh

Rice production in Bangladesh might be perceived by an outsider as a simple technology practiced by simple farmers, but this is not the case. Bangladeshi rice farmers, subsistence or larger, are faced with complex decisions which must frequently be modified without warning. Some factors in these decisions are the season, availability and cost of inputs, too little water/too much water, need for other crops, and the instinct to survive.

Developing rice varieties for this client group is no less complex. The breeders are faced with the challenge of developing varieties for three distinct, sometimes overlapping, crops per year in 30 different ecosystems, each of which exhibits unique fertility, drought, cold, salinity and/or flooding problems. Rice farming systems require greater and greater intensification, increasing the risk of pest outbreaks. Breeders must also consider specific grain quality and grain-to-straw ratio requirements in their varieties.

BRRI, although nominally a single-crop institute, faces many of the same problems and challenges as does a multicrop institute, given the diverse requirements of rice varieties, cropping systems, ecosystem adaptation, and use (grain, straw). Other annual crops in Bangladesh tend to be season-specific (wheat, pulses, mustard) so the demands upon researchers are not so great; they have some "breathing" time between harvest and planting. BRRI, because of the nature of the distinct rice types required and the pervasiveness of the crop throughout the country and throughout the year, has a special mandate and an imposing challenge. The nation's ability to produce sufficient grain (including wheat) for its people will in all likelihood determine its potential to diversify its agriculture; the special place of rice in the hearts as well as in the stomachs of Bangladeshis adds another dimension to BRRI's work.

B. Contribution of Rice Breeding to Bangladesh

The contributions of BRRI toward the goal of increased rice production in Bangladesh have been substantial. Since its inception in 1973, the institute has released 26 varieties of rice. Of these, six were introduced from other countries, evaluated under Bangladeshi conditions, and released. The other varieties were developed from BRRI's breeding program using both local and exotic germplasm to create adapted lines with unique qualities for specific farming system utilization. The contribution of BRRI varieties to national production can be documented by the yield and area of production statistics (annex D, tables 1, 2, 3). The marginal internal rate of return on research investment at BRRI has been shown recently to be an astonishing 165 percent (Dey et al.). The authors emphasize that the research impact is a result of both breeding and non-breeding research at BRRI. On-farm surplus rice

production is produced mainly by farmers with more than one hectare of land; however, the adoption of MVs[1] by the largest farmers is not as high as adoption by small farmers—42 percent versus 52 percent (Hossain). As of 1990, BRRI varieties produced 55 percent, 37 percent, and 66 percent of the total crops of aman, aus, and boro, respectively.

There is concern in some quarters that MV yields have deteriorated since their introduction in the early 1970s. Some have taken this to mean that the newer varieties are not as good as the originals. This is not true, as shown by BRRI data supporting new varieties. Others view this decline in yield as evidence that the soil resource (fertility, organic matter, tilth) is deteriorating. There are probably data to support this hypothesis in some areas. More likely, the apparent decline is occurring because MVs are moving into less favorable areas and are increasingly grown by farmers without the use of other recommended inputs which they cannot afford. MVs, even without all of the additional inputs, are still superior to the local lines.

Modern varieties first had an impact in Bangladesh with the release of Pajam in 1966 and IR-8 in 1967. IR-8 became known around the world as the "miracle rice" which fueled the Green Revolution in rice. This semi-dwarf wonder was the model for the next generation of varieties in Bangladesh and wherever rice was grown. However, the release of the short stature varieties IR-20, Purbachi, BR-1 and BR-3 (the first variety from a BRRI cross) in Bangladesh was not as popular as expected. These varieties lacked two essentials: adaptation to the varied agroecological conditions of the country (flooding, drought); and straw. To many Bangladeshi farmers, straw is a very important household commodity (fuel, feed, brickmaking, thatching, soil amendment). A major decision was made by BRRI breeders to rectify this problem through the development of MVs with "intermediate" plant height while attempting to maintain the yields of the HYVs.

Because of its overwhelming importance in the agriculture sector, rice was identified with specific objectives within the third five-year plan, 1985-86 to 1989-90. The 1989-90 production targets for the aus, aman, and boro crops were 3.42, 9.18, and 5.40 mmt, respectively. In fact, the Ministry of Agriculture estimated production for 1989-90 at 2.49, 9.02, and 5.60 mmt, respectively. As a result, the projections for the total rice crop exceeded production by only 0.9 mmt. (Wheat production was 1.24 mmt below target.) The targeted increase of grain production of 5.2 percent per year was not achieved. In fact, during the first three years of the plan, the rate of increase was a disappointing one percent. The major flood of 1987, followed by the devastating floods of 1988, vividly demonstrated the vulnerability of the country's agriculture to natural calamities and the difficulty in projecting production.

During 1988-1990, the flooding situations were more "normal," and the GOB made some important policy changes which significantly impacted the production situation. Private dealers were allowed to import diesel motors without taxes or restrictions for use in

---

[1] MV is a more inclusive term than HYV in that while it may include HYV it could also include varieties with critical qualities other than yield such as pest resistance, drought and or cold resistance, photoperiod sensitivity, shorter growth cycle, etc. of economic value to the farmer.

irrigation. The resulting lower prices stimulated sales of shallow tube wells and low-lift pumps in excess of 50,000 units in less than a year; during the same period, the sale of deep tube wells increased from 500 units to over 3,000. These changes and others such as the decontrolling of fertilizer distribution to permit private dealers to compete with the Bangladesh Agriculture Development Corporation (BADC), the elimination of restrictions on the importation of pesticides, and the removal of duties and standardization from power tillers (resulting in the importation of over 10,000 machines), led to a record boro yield and a rebound in production of 14 percent during the year 1989-90. Other policy changes being contemplated, such as greater privatization of the seed industry, should have a continuing and increasing impact on production during the fourth five-year plan. Policy changes involving irrigation, fertilizer, and seed can have very significant impacts, as these are essential inputs for high technology rice.

The objectives for rice production during the fourth five-year plan are more realistic than in the previous plan (3.6 percent versus 5.2 percent, rice plus wheat). The current plan has increased the emphasis on diversification. The plan also states, however, that:

> "because of the primacy of rice in both production and demand, attempting to broaden the diet of the nation requires significantly improved food grain production efficiency—precisely because it is only through such improvements that adequate amounts of land can be released for growing other crops."

The above quotation emphasizes the importance of continued GOB and donor support for BRRI. So much of the success of other agricultural endeavors, including the development of a significant market for locally-made industrial products and inputs and increased rural demand for labor, depends upon the continuing outstanding contribution of BRRI.

C. The Rice Breeding Program

The rice breeding program is typical of a breeding program for a self-pollinated crop. Like most conventional programs, the time required to release a variety to farmers is 12-15 years from hybridization (annex D, figure 1). The Biotechnology Division is working to shorten the time required through the use of tissue culture and anther culture (haploidy). The other factor in the process which may be shortened is the period between recognition of a potential new variety by BRRI scientists and seed release to BADC for increase.

Under the current system, the National Seed Board must register varieties of rice. The NSB, through its Technical Committee, monitors regional tests of potential new varieties to determine whether registration of the variety can be supported. It would seem that when BRRI scientists have generated sufficient regional data to satisfy themselves that the line can become a variety, the Technical Committee should be capable of making the decision from the data: field inspections should not be necessary. The regional yield trials should be sufficient to determine whether a potential new variety, compared to local lines or existing MVs, justifies registration. Further on-farm testing (such as Advanced Lines Adaptive Research Trials, ALART) may identify areas where the new variety is uniquely well adapted.

Once a variety is registered, the breeding institution (in this case BRRI) is responsible for maintaining a supply of breeder's seed. However, it should not be the role of BRRI to produce Foundation I or II seed. The resources of BRRI (physical and human) are too important to the research process to be squandered on the seed multiplication process, which is currently the role of BADC. It does seem appropriate that BADC should gradually withdraw from the production of certified seed and leave this function to seed companies and/or commercial seed growers. As a commercial seed industry evolves, expertise should develop within this group to receive breeder's seed directly and conduct the entire pedigreed seed increase and marketing process.

The above process describing development of a variety is similar for boro, aman, and aus lines. The overall scope of the program is illustrated in annex D, table 4. Participation in cooperative international testing is both an obligation and an opportunity. As a significant participant in the international network of rice research institutes, BRRI carries responsibilities for the broader good; at the same time, participation in the international testing programs ensures that BRRI breeders will be very familiar with the best germplasm from around the world. Such germplasm may occasionally be useful directly as new varieties; more often, it can be used as parental material for crossing or as germplasm for the Genetic Resources Division. The International Network for Genetic Evaluation of Rice nurseries represent a significant time commitment to the system while the Southeast Asia Agricultural Research Council (SAARC) nursery is quite modest in terms of effort.

Because the BRRI program made a conscious decision to develop MVs which were somewhat different (some taller, local adaptation) from the HYVs developed in many other countries, the germplasm base of the current BRRI varieties may not be quite as narrow as that of some other countries. However, as intensification of the crop increases in the future, the risks will increase. No breeding program can make genetic diversity the prime objective as the progress in yield would suffer too badly. Further, no one can predict what catastrophic disease or insect might strike, and no program can guard against every possible event. The BRRI can guard against disease and insects in two ways. First, as part of its participation in international tests, it may identify high-yield materials which are genetically quite different from the high-yield materials in the BRRI program. These might be retained as varieties for direct use in Bangladesh or, more likely, as parents for crossing in the breeding program. Second, the Genetic Resources Division has a major collection of thousands of seed accessions of local and exotic lines. It is estimated that there are approximately 1,000 local lines in Bangladesh, about half of which have been collected and described. These lines, because they co-evolved with the pests present in Bangladesh, may represent the greatest potential source of stability against disastrous outbreaks. Further, BRRI has access to the germplasm banks of other cooperating institutes. These resources, plus continuous monitoring of the pest situation in the country, can give some stability, though a disaster scenario can never be completely ruled out.

D. The Rice Breeding Program Objectives

The breeding program at BRRI has four overall objectives:

- To develop new rice varieties adapted to the diverse ecosystems of Bangladesh.

- To collect, evaluate, and conserve local and exotic germplasm for use in breeding and as a "storehouse" for genes of potential value.

- To utilize the elite germplasm of the world for varietal development.

- To utilize the new techniques of biotechnology to speed up the breeding program or create new variability.

More specifically, Dr. N.M. Miah, Head of Plant Breeding Division, BRRI, has listed the specific breeding objectives as follows:

- Broadcast (upland) aus varieties
- Improved deepwater aman varieties
- Rainfed lowland varieties
- Photoperiod sensitive varieties for aman
- Tidal submergence tolerant varieties
- Cold-tolerant varieties
- Salinity-tolerant varieties
- Drought-tolerant varieties
- Early maturing varieties
- Disease- and insect-resistant varieties
- Appropriate quality varieties

A given objective in all breeding programs is yield and, as indicated earlier, intermediate rather than short stature. Many of the varieties released by BRRI over the past few years have been released for characteristics other than yield, although yield has not suffered. For example:

- BR-8 and BR-9 were released to replace BR-2. The newer varieties were taller, had less spikelet sterility, and fewer threshing problems.

- BR-10 and BR-11 were improvements over IR-8, IR-20 and BR-4 in that they were taller with greater adaptation to late planting in T aman because of the greater sensitivity to photoperiod.

- BR-12, BR-14, BR-15, and BR-16 were taller with greater resistance to BLB and RTV than BR-3.

- BR-17, BR-18, and BR-19 are improvements over other boro varieties because of their early cold tolerance and adaptation to haor areas. They are also somewhat taller.

- BR-20 and BR-21 are particularly adapted to direct seeded upland aus conditions. They have better drought and lodging resistance.

- BR-22 and BR-23 have greater photoperiod sensitivity than BR-4, BR-10, and BR-11. These T aman varieties can be planted later (up to September 30) with a lesser yield decline.

E. Servicing the Agroecological Regions

Bangladesh was recently divided into 30 distinct agroecological regions (annex D, figure 2). It is not the intent, nor would it be practical, for BRRI to direct specific breeding programs to all 30 zones. Instead, BRRI recognized several broad rice ecosystems in which, in most cases, the breeding program has research facilities to screen and evaluate its lines. The rice ecosystems serviced by BRRI include:

1. Irrigated rice (boro): low lying areas (haor) in the northeastern part of the country and areas with a reliable source of water from rivers, deep and shallow tube wells. The main stations involved include Habiganj, Comilla, and Bhanga.

2.(a) Direct seeded aus: these areas tend to be centered in the western, northwestern, and eastern parts of the nation. They are typified by flood free upland areas, frequently drought-prone. Research in this area is centered in Rajshahi and Kushtia (Chitla).

(b) Transplanted aus: these areas are basically the same as 2(a), above. However, these areas can be irrigated in the early stages of growth, where irrigation is available. T aus research is conducted at Gazipur, Brisal, Comilla, Rajshahi, and Kushtia.

3.(a) Transplanted aman: rainfed lowland areas with varying degrees of difficult problems.

(b) Favorable: this includes medium-high to medium-low altitudes all over the country. This ecosystem is served mainly by Gazipur and Comilla.

(c) Unfavorable:

(i) Drought-prone: higher in elevation than 3(a) above and frequently rice is affected by drought at the critical reproductive stage.

(ii) Submergence-prone: constitutes the same areas as (i) above except it is frequently exposed to flash floods.

(iii) Tidal, Saline zones: these are in the southern coastal areas and include areas in the Patuakhali, Khulna, Bagerhat, Bhola, Borguna, Feni, Noakhali, Chittagong, and Cox's Bazaar. Sonagazi was established to service this zone.

(iv) Tidal, non-saline areas: involve Barisal, Pirojpur, Jhalakati and parts of Patuakhali, Bhola, Khulna, and Satkhira. This rice ecosystem is serviced primarily by Barisal.

(v) Medium-deep stagnant water occurs in parts of Khulna, Jessore, Faridpur, Bagerhat, and Satkhira districts. These is currently no station to service these districts, so many trials related to this zone are conducted on farmers' fields.

4. Deepwater rice zones are concentrated in the Greater Sylhet, Tangail, Jamalpur, Comilla, Dhaka, and Faridpur districts. The research stations dedicated to deep water rice are Habiganj and Bhanga.

In conducting research at these stations, BRRI covers a major portion of the country (annex D, figure 3). BRRI varieties tested at these locations will be adapted specifically to those agroecological regions and may be adapted to broader areas. The major agroecological regions (1, 3, 11) not currently covered by BRRI research stations may be covered by locating regional yield trials at BARI stations in those regions. The location-specific adaptation of varieties to the 30 agroecological regions will only occur with the "fine-tuning" that comes about in ALART and Proposed Variety Adaptive Research Trial (PVART) testing.

IRRI, like several other centers in the Consultative Group on International Agricultural Research, has recently redefined its mandate to fit an ecosystem approach. For a center with a very broad mandate, like IRRI, this would appear to be a sound move. IRRI has identified five major ecosystems: irrigated, rainfed lowland, upland, deepwater, and tidal wetlands (the underlined terms in the BRRI ecosystem definitions above). BRRI researchers include tidal wetlands in rainfed lowland areas; otherwise, BRRI's overall approach to defining adaptation of a variety is not that much different from IRRI's. The continuing use of aus, aman, and boro within the BRRI description has historic meaning in Bangladesh. IRRI, with its multinational orientation, has had to simplify its nomenclature. Whatever the nomenclature, whether servicing ecosystems or servicing seasons within ecosystems, the ultimate result is probably the same in terms of selection of parents in the breeding program, selection of advanced breeding material, and the variety that ultimately comes "out the pipeline." The difference in terminology is probably more semantic than philosophical. Further, dropping the aus, aman, and boro designations at this time would probably be confusing to farmers, extension personnel, administrators, and even some donors.

F. Rice in the Future

A recent paper by F.U. Mahtab and Z. Karim identifies three main approaches to increasing rice production in Bangladesh: increased cropping intensity, more and better rice varieties, and more and more effective extension to accelerate adoption of new technology.

Cropping intensity will be largely influenced by irrigation availability. The authors indicate that there are currently 3 million hectares (m ha) under irrigation and this could climb to 5.8 m ha. Aus area could increase from 0.59 to 2.1 m ha; aman from 0.83 to 2.85 m ha; and boro from 1.51 to 1.71 m ha (under the most optimistic scenario, up to 3.0 m ha). They project that yields could be increased to 2.0 - 2.5 tons per hectare (t/ha) on the aus and aman area and 5 t/ha on the boro. Irrigation is essential for the boro crop and, as irrigation availability increases, the area planted to boro will undoubtedly increase. However, modest amounts of irrigation in the early growth stages of the aus or the late stages of aman crops could have most significant effects on the yield of these crops and, perhaps, take some of the pressure off rice production in the boro crop. As indicated earlier, if with the increased availability of water there is a major expansion in the boro crop without HYV, the potential for crop diversification would be significantly reduced. With the development of HYV, the greatest potential for rapid change in rice production would be in boro. A major yield increase in the boro yield could, in fact, reduce the land area required for boro and increase the likelihood of successful expansion of diversification crops.

The current cropping intensity is 1.55. In much of Bangladesh, two crops per year is not an unreasonable objective; in some areas, with specific crop combinations, three or even four crops per year are not impossible. With increased irrigation availability and the proper selection of variety, the cropping intensity could reasonably be increased to 2.25 or greater. A significant part of the challenge of the rice farming systems research group at BRRI will be centered on increasing cropping intensity in a sustainable way.

Development of varieties for the future will have a greater impact on the nation's ability to feed itself than any other factor. Bangladesh's rice production increases in the past few years have been most commendable. From 1976-77 to 1985-86, annual per capita grain production increased from 393 kg to 423 kg. Obviously, the rate of increase in grain production was greater than the rate of increase in population growth. However, the rate of increase in rice production in Bangladesh lagged behind most of its neighbors. Between 1965 and 1985, rice production in Bangladesh increased 43 percent (Khush), the second lowest rate of increase of 13 nations. The performance of some other countries ranged up to 202 percent for Indonesia, 187 percent for Sri Lanka, and 163 for Pakistan. All except two of the countries included in the comparison had higher adoption rates of MV technology than Bangladesh had. For a variety of reasons, the prognosis for increased grain production for Bangladesh in the next few years is good. The GOB is facilitating the distribution of inputs (irrigation equipment, fertilizer, seed) through changes in policy which are encouraging privatization. These changes should facilitate the move toward greater cropping intensity. Also, development of HYVs appears to offer significant potential.

With the boro crop, the main future emphasis will be yield. As indicated earlier, the plant breeders at BRRI made a decision several years ago to break with the IRRI philosophy of short stature HYV lines to develop medium height MVs instead. This was a rational decision based upon an expressed need for straw, particularly for fuel. In developing taller varieties with a greater proportion of straw, grain yield tended to suffer. As a result, Bangladesh varieties were not true HYV in the sense that yield was the overwhelming criterion in their development. They were appropriately called "modern varieties." As

pressure for increased food production builds, the plant breeders will have to place greater emphasis on grain yield, in part at the expense of straw yield, for the development of true HYV.

There is no doubt that there is a shortage of biomass for fuel, but rice straw and stubble (or dung) are inappropriate sources to address the problem. More direct means such as agroforestry or bottled gas should be developed. BRRI breeders have some yield potential to make up to achieve the increases which most other nations in the region have achieved using the IRRI concept and germplasm. Most countries have consolidated their large yield response from the IRRI lines through the incorporation of disease and insect resistances (to local pests) and improved grain quality (for local tastes). There has been little increase in the yield potential of rice since the basic architecture of the plant was changed 24 years ago. IRRI is looking to change the yield plateau of rice again by increasing the harvest index (i.e., grain:straw ratio) preferably with an increase in total biomass. Also, current HYV produce 20-25 tillers, of which 15 to 16 are fertile. Sterile tillers compete with fertile tillers for photosynthate. It is proposed that plants with 4 to 5 very productive tillers, sturdy stems, erect dark green leaves, and vigorous root systems may provide the next breakthrough. BRRI breeders have these objectives to work toward, as well as greater genetic pest resistance, cold tolerance, and improved grain quality.

The major areas of rainfed lowland rice (aman) would be improved with late season accessibility to irrigation and/or genetic drought resistance. These lines also require submergence and/or salinity tolerance for specific agroecological areas. This is the most widely grown crop, so varieties with specific adaptation to areas are required. The activity of BRRI in developing photoperiod sensitive lines of T aman is important for greater yield stability and the potential for greater system (annual) production even though the yield of the T aman crop itself may be less. The large inventory of local lines are of this type and represent a great repository of potentially valuable germplasm. A continuing breeding objective must be disease and insect resistance.

The objectives in the deepwater rice program include development of Ulfa and Root Knot Nematode resistance and the transfer of Rice Tungro virus and Bacterial Leaf Blight resistance into the breeding lines. In Bangladesh, deepwater rice requires tolerance of water depths of 3-4 meters. The grain-to-straw ratio of these lines is very low (2:8) but this would appear to be a necessary limitation.

The upland aus area is typified by diversity of soils, rainfall, and topography. Drought stress is not uncommon during the early growth stages. As with the deepwater rice crop, farmers are reluctant to invest much in inputs, compared to the boro crop. The breeding objectives therefore include stress resistance (especially drought, acid) and responsiveness to moderate levels of input. Increased yield and shorter growth duration are desirable objectives as well.

There is currently a big gap between available technology and the technology adopted by farmers, indicating a significant problem in technology transfer. When assessing the success of the major increase in rice production in Bangladesh over the past 20 years,

organizations other than BRRI claim part of the credit. DAE and BADC have certainly played a significant role in moving technology, including seed, to the client group. When, as the situation appears now, there is a major gap between development of technology and its adoption, it would seem that these two groups have a particular obligation to rectify the situation. The demonstration method of extension has recently been shown to be much more important than the training and visitation system. Both DAE and BADC must reassess their approaches to magnify their effects in rural areas. It has been suggested that a more formal working relationship with NGOs, including the Grameen Bank, Mennonite Central Committee, and others would be in the interest of all parties.

An appropriately structured and supported BRRI would be well-positioned to help Bangladesh confront a major dilemma in the years to come: increased food production for a rapidly growing population with a limited land base. It is estimated that the current population of 115 million will swell progressively to 145, 177, and 233 million by 2000, 2010, and 2030, respectively. This would require 25.5 mmt of grain in the year 2000 and 32 mmt by 2010.

The potential to develop true HYVs remains in Bangladesh and should be pursued. The newer research areas of molecular biology may provide the impetus for the next major yield expansion. Some inherited characteristics (for example, herbicide and insect resistance) may indeed be manipulated now and in the near future in certain crops. However, important attributes such as yield, nitrogen fixation, and photosynthesis are controlled by many (perhaps hundreds) of genes and do not lend themselves to easy manipulation in the foreseeable future.

Although increased irrigation and fertilizer/pesticide applications were the tools of the Green Revolution in the 1960s, concerns over concomitant environmental degradation are now mounting. It will be particularly challenging for researchers and politicians to rationalize the sometimes conflicting priorities of yield enhancement and environmental integrity at the farm level. The greater the constraints placed on the use of external inputs (fertilizers, pesticides, etc.), the greater the demands on the plant breeder to incorporate compensating genetic attributes into new varieties, and for other agricultural scientists to develop technologies to enhance sustainability. Increasingly, the international scientific community is calling for new research methodologies and technologies to respond to far more difficult challenges than those confronted by the Green Revolution researcher.

All these concerns point up the critical future role of BRRI in feeding the Bangladesh population. The country's ability to produce rice in excess of its requirement can open the way to greater diversification of agriculture and greater economic development in rural areas.

SECTION III
IRRI/BRRI PROJECT ACTIVITIES IN DEVELOPING AND FIELD TESTING ECONOMICALLY APPROPRIATE TECHNOLOGIES

A. Overview of BRRI On-farm Field Activities

The Rice Farming Systems Research Division of BRRI pioneered site-oriented systems research in Bangladesh. From 1976 to 1981 a cropping systems research program was conducted in several agroecological zones. Recommendations from the earliest cropping trials at Bhogra village had relevance for a wide area of level, heavy highland soils subject to shallow flooding in the monsoon season.

In 1982, BRRI scientists initiated a multilocation test program in farmers' fields in close cooperation with Directorate of Agriculture Extension personnel to further verify and refine cropping technologies in the extrapolation areas. This program provides field tests of rice varieties in rotation with other rice and cereal varieties under farmer management conditions. It is not a whole farm research program, but provides useful yield information under control and treatment replicated trials. (Since 1978 BRRI has had a Memorandum of Understanding with DAE pledging both agencies to cooperation in the on-farm technology testing and transfer process.) Other MLT activities include: 1) demonstrating research results to farmers; and 2) training extension personnel.

In 1991 BRRI operates 41 MLT sites in conjunction with DAE district and *upazila*-level staff in most of the 30 identified agroecological zones. Individual sites are usually maintained for two to three years, after which research activities are discontinued in favor of a new site. This methodology promotes development of proven technology packages reflecting on-farm research results conducted over time in a wide geographic area. It precludes the need to install expensive infrastructure and permanent professional staff at the research site.

In the early 1980s livestock activities were added onto the narrower Cropping Systems Research (CSR) and promoted by international donor agencies. An extension component was also added. The expanded framework became known as Farming Systems Research and Extension (FSR/E) system. This approach was not, however, immediately adopted by BRRI, which remains predominately a specialized rice research institute.

In 1987, BRRI undertook an impact assessment in two areas where MLTs had been conducted (Kamalganj and Sitakund). These assessments included analyses of livestock and nonfarm enterprises, along with measurements of women's farm and household activities. Although not formally recognized as full-fledged FSR by BARC leadership charged with coordinating the NARS, the analyses conducted by BRRI addressed all components in the farming systems approach. These impact analyses preceded introduction of a full FSR/E

strategy in BRRI, which is now represented at the Sreepur site just outside the main station at Gazipur. Included in this research and demonstration program are livestock, fishery, and agroforestry activities, and introduction of women-oriented homestead vegetable and poultry activities. Funding through the BARC coordinated system has to date not been forthcoming to sustain this activity beyond the current fiscal year. Without additional funding, BRRI FSR/E activities will not be conducted in 1992 or following years.

B. Defining Farming Systems Research

Defining the distinctions used by differing funding and implementation agencies to distinguish between CSR, FSR, and FSR/E is not a simple undertaking. On the surface, it might seem easy to differentiate on-farm research programs:

- CSR: limited to crop experiments.
- FSR: includes livestock, fisheries, agroforestry, and homestead production components.
- FSR/E: includes advocacy introduction of new crop and livestock activities in addition to promoting targeted extension activities such as home garden development, confined poultry rearing, agroforestry, and fish/rice activities.

In practice these distinctions are not so clear.

Since the early 1980s, donor-supported FSR on-farm activities have been broadened by introducing technology transfer beyond the traditional crop-based orientation of BRRI. The expanded programs require expensive infrastructure and permanent site-specific professional staffing. Sites tend to become mini-research stations managed by scientists rather than farmers. These activities have increased the cost of on-farm research and make the research nature of activities more tenuous and confusing. More importantly, new activities of an advocacy nature included under the FSR/E framework in the name of research have put additional strain on research budgets which have, for the most part, declined in constant taka over the past five years.

Definitional distinctions associated with the broadened FSR concept have made it difficult for the evaluation team (as well as the research establishment in Bangladesh) to develop a consistent count of FSR/E sites now operated in the country by various research institutes. In part this is because a common definition of FSR research has not yet been developed. A 1990 paper by a BRRI scientist identifies 25 FSR/E sites in 1990, including three coordinated by BRRI (Sitikund, Kamilganj, and Sreepur.) FSR research results from the Sitikund and Kamilganj sites resulted in an award-winning paper presented at a recent regional FSR research symposium in Bangkok. Yet, these sites were not included within the BARC count of FSR/E activities.

Further confusion is introduced by a lack of consistency in the type of research included within the FSR scope. The recently completed USAID evaluation of the Agricultural Research Project II (supplement) suggested a broad range of research activities within the FSR framework, including exploratory verification and demonstration and

production trials. This suggests that yet additional research activities must be completed before technologies can be extended to farmers.

BRRI, however, adopts the view that FSR involves primarily field testing and demonstration of new varieties to develop rotational technologies and adaptive cultural practices for the entire farm environment. An important component of this approach is that results are obtained under farmer management conditions.

The team concurs that the narrower interpretation of FSR activities used by BRRI is best suited to the technical orientation of the institute and the disciplinary skills it comprises.

Moreover this approach is less costly than approaches dependent on heavy investment in permanent site infrastructure. It has the further advantage of site flexibility which promotes accumulation of a wider body of knowledge over additional agroecological zones.

Shrinking donor funds for agricultural research suggests that objective evaluation of returns to permanent sites be made relative to the costs involved in managing activities on these sites. During team discussion with FSR/E specialists outside of BRRI, it was learned that only about eight mature technologies have been recognized to date as a result of FSR research covering more than 20 sites in rural Bangladesh.

C. Farming Systems Technologies Tested and Released by BRRI

A review of BRRI FSR reports suggests that the following new farming system cropping technologies have been successfully tested by BRRI since 1989:

- Rainfed direct seeded MV aus)/ MV T aman cropping pattern for *chala* (upland) in an acid upland environment.
- Rainfed transplant MV aus)/MV T aman cropping pattern for *byde* (lowland) in an acid upland environment.
- Intercropping of sugarcane with kangong (*Ipomoea*) and amaranthus in an acid upland environment.
- Zero tillage practices in T aman crop in high, rainfed, northeastern Bangladesh.

In addition, all MVs approved by BRRI for use by farmers have been extensively tested under farm management conditions on MLT sites. These site-specific variety rotation trials, conducted under farmer management conditions, provide researchers and extension workers with valuable information regarding performance across almost all agroecological zones. They provide insight into special attributes and problems associated with new and existing varieties under field conditions throughout the country. The research methodology used requires that sites be changed at least every three years. This promotes widespread coverage of variety and rotational adaptability under many agroecological zones.

Three livestock-related technologies are now under observation in the Sreepur FSR site managed by BRRI. These technologies are targeted primarily towards women and include:

- Confinement poultry rearing under small farm conditions.
- Goat fattening under confinement using readily available feed resources.
- Raising improved scavenging poultry breeds.

While the above activities provide an introduction to improving productivity and the income generating capacity of women farmers, introduction of other improved rice-based technologies can also be tested under FSR conditions, including improved parboiling and other postharvest technologies designed for small village or household use. **The team recommends that BRRI actively develop and test within its FSR strategy postharvest rice-based technologies to meet the needs of rural women working in small village homestead sites.**

D. Some Future Directions for Farming Systems Research at BRRI

At present, varietal performance trials are conducted under alternative fertilizer application rates and tillage systems on BRRI FSR sites. Results of FSR activities at Kamilganj and Sitikund completed by the FSR Division suggest that poorer farmers with marginal land holdings have greater adoption rates of new BRRI MVs than do farmers with larger land holdings and presumably greater financial security. This result is interesting in that it is often expected that small scale farmers will be slow to adopt new technology, based on the assumption that MVs require higher management and increased application of commercial fertilizer. Under these conditions small scale farmers with a limited cash resource base will be less able to afford the cost of inputs required to take advantage of higher MV yield potential. A review of the results (annex G) indicates that smaller farmers used higher fertilizer inputs and realized larger net returns from rice than did the medium and larger scale farmers who were slower adopters and used less fertilizer.

FSR research activities conducted by BRRI can benefit from additional inputs from agricultural economists. Existing FSR research does not systematically include analysis of small farm commercial viability. While a limited amount of farm economy analysis is now undertaken, more should be done. BRRI agricultural economists can use data now being generated by FSR to develop cost of production, input use, and gross margin calculations. The FARMACTION computer program being developed by BRRI with support of the IRRI FSR specialist can contribute to achieving this objective.

Data appear available from existing BRRI FSR research to conduct farm management cost of production and returns to family resources which can provide additional knowledge concerning potential for commercial development by small, medium, and larger scale farmers. Incorporating this type of farm production economic analysis across all FSR sites can provide systematic information on the commercial viability of small farms, their capacity to absorb commercial credit, and net farm income growth potential under alternative technology patterns. Similar analysis is needed for medium and large scale operations which

have the most future commercial potential. (Small scale operations are identified as those with less than 0.4 ha, small operations are those with 0.41-1 ha, medium operations are those with 1.01-3 ha. Farms with more than 3 ha are considered to be large operations.) Supplying economic analysis of a wide range of rice growing conditions in Bangladesh can provide important new knowledge concerning the potential for commercial viability of small scale farming. The information gained may contribute significantly to the ongoing policy dialogue regarding commercial farmer development in Bangladesh.

To conclude, it appears that the major weakness in FSR research now conducted by BRRI is lack of systematic economic and financial analyses to assess commercial viability of the whole farm systems analyzed under farmer management conditions. **We recommend that BRRI place high priority on systematically integrating farm production economic analysis into its FSR research design and analysis procedures.**

BRRI has developed a proposal to initiate FSR activities and impact studies on six sites representing:

- Rainfed lowland favorable environment: Sitikund, Kamilganj
- Rainfed upland favorable environment: Khustia/Jessore
- Rainfed acid upland Madhupur tract: Sreepur
- Rainfed lowland drought prone (Barind tract): Rajshahi
- Flood-free irrigated environment: Comilla
- Deepwater winter irrigated environment: Mirzapur

Introducing FSR study sites in these environments can provide on-farm information for extension and research potentially adaptable across a large part of rice growing areas in Bangladesh. No new expensive infrastructure or facilities are required although annual operating funds are needed. **Based on the BRRI FSR track record to date, the team urges funding agencies to support future BRRI requests for operational funds to expand on-farm FSR activities. However, because of the limited supply of research funds in the BARC system, BRRI should be willing to implement the program on a step-by-step basis as funds become available.**

E. Multilocational Cropping Trials

Multilocational trials are conducted under farmer field conditions. They are part of the series of field trials of rice varieties either singly or as part of a rotation with other rice, cereals, or green manure crops. Although some trials are made using promising advanced varieties, most varieties included in MLT are approved varieties (some newer varieties may still be pending release by the NSB). Extension staff are closely involved in selecting MLT sites and farmer participants. Extension staff often work closely with BRRI scientists in managing these trials.

Although there has been close collaboration between the extension service and BRRI in the MLT program, it is doubtful whether the extension service will be in a position to take on increased funding responsibilities for the program in the future. This has more to do with

the decentralized nature of extension service funding and administrative control than it does with a lack of interest on the part of local level specialist or generalist staff or the central DAE administration.

With introduction of the decentralized *upazila* administrative system in 1983, financial and administrative control of extension subject matter officers and block supervisors passed from central extension authorities to *upazila* councils. As a result, all decisions regarding personnel and funding collaboration between extension staff and BRRI MLT activities in a particular *upazila* depend almost entirely on gaining approval from local councils. Consequently, it is not possible to anticipate widespread local-level implementation or financial support for MLT activities even if this were endorsed by the central extension administration. In some localities such support may be forthcoming from time to time, but it will most likely be as a result of relationships developed between individual researchers, extension agents, and the *upazila* council.

Nonetheless there does not seem to be any major problem associated with continued technical collaboration by local extension staff with MLT sites located in their districts if support from *upazila* councils is forthcoming. It is important to emphasize that retaining good *upazila*-level relationships is key to continuing or expanding all collaborative arrangements between BRRI and extension staff at this level.

SECTION IV
BRRI ACTIVITIES ASSISTING AGENCIES AND ORGANIZATIONS WORKING WITH FARMERS TO INTRODUCE IMPROVED RICE VARIETIES

BRRI has developed close working relationships with the DAE and has pioneered close working relationships with NGOs in the past. In addition it has engaged in a very effective direct technology transfer activity on at least one occasion.

A. BRRI Collaboration with the Directorate of Agriculture Extension

BRRI has had an MOU with the DAE since 1978. It is updated periodically and provides the basis for collaborative interactions between the two organizations. The most recent MOU, dated 17 March, 1987, commits the two agencies to conducting joint field activities including verification of Farmer Variety Observation Trials (FVOT), ALART, and MLT trials on DAE-managed and other sites.

The MOU requires that the DAE provide a senior officer, resident at BRRI, to coordinate joint activities in curriculum development; conduct and evaluate training of DAE staff; plan and conduct MLT, FVOT, and ALART trials; assist BRRI staff in devising and evaluating alternative methods to accelerate farmer adoption of improved technologies, and assist BRRI scientists to put research findings into formats suitable for extension purposes. The liaison officer, appointed for a three-year period, is also responsible for selecting DAE staff for training and working with mobile training teams at major BRRI regional stations. The DAE staff are expected to identify MLT, ALART, and FVOT sites in collaboration with BRRI staff and to undertake data collection and site supervision activities.

Under the MOU, BRRI staff conduct DAE staff training at regular intervals. The purpose is to develop and improve skills required to assist BRRI scientists conducting field trials, such as FVOT and ALART, which directly support the varietal improvement program. Although not specifically identified in the MOU, the DAE also cooperates with MLT and FSR technology adaptation activities.

BRRI provides less intensive training for DAE officers and other government and NGO staff working in the area of transferring rice production technologies. Some eighty individuals per year, including farmers, are trained in two three-month courses. BRRI does not hold farmer field days at FSR sites.

These training activities provide useful opportunities for BRRI researchers to interact with technology transfer agents in the public and private sectors. However, it is not possible for BRRI to interact directly with farmers outside their adaptive trials and FRS research and demonstration sites. It would appear that the best use of BRRI expertise to promote technology transfer is to adopt a "training of trainers" strategy. **The team recommends that**

BRRI FSR and agricultural economics staff expand practical short courses given to extension staff and NGO representatives operating in the agricultural sector at local levels. The focus of this training should be on cultural practices required for most efficient use of MV and HYV rice including crop rotational patterns which can increase farm income. **Regular farmer field days should be included as part of the BRRI expanded technology transfer activities.** In addition to providing medium impact technology transfer, they provide an excellent opportunity for research staff to get first-hand feedback from farmers.

As noted above, the collaborative BRRI/DAE activities provide BRRI with assistance in managing field level varietal testing with on-farm testing under the FVOT and ALART programs. It is noted, however, that the MOU does not directly address joint BRRI/DAE collaboration: 1) in selecting FSR sites; 2) in collaborative implementation of research activities on these sites; 3) for expanded DAE activity in developing outreach programs; or 4) in using FSR sites for extension demonstration purposes. **It is recommended that future MOU arrangements between BRRI and the DAE explicitly provide for BRRI/DAE collaboration in all phases of farming systems research and extension work.** For its part, extension should be willing to take on a stronger demonstration role than has been the case to date. District level subject matter specialists would provide the most appropriate level for this collaboration.

In making the above recommendation the team is aware that under the existing decentralized extension service administration approval for *upazila*-level collaborative activities must come from *upazila* councils. For this reason, collaboration with district level subject matter specialists, who remain under the direction of headquarters, is the most appropriate to provide extension leadership with the FSR program.

B. Coordinating Research Activities with Other Organizations Engaged in Technology Transfer Activities

In the 1970s BRRI pioneered collaborative activities with NGOs working in the area of technology transfer. BARC-coordinated FSR/E activities do not now include NGOs within the technology transfer collaboration network. Reasons for this are unclear. **We recommend that additional collaboration between BRRI and NGOs engaged in technology transfer should be pursued.**

Numerous local and expatriate-led NGOs (listed in annex F) have developed effective technology transfer programs and/or outreach activities across a broad spectrum of agricultural activities. **Arrangements such as those existing with the Mennonite Central Committee, which participates in FSR activities, should be facilitated with other interested and capable NGOs.**

The success of these collaborative arrangements will, quite naturally, depend on the availability of funds. Donor agencies such as USAID and CIDA are becoming increasingly receptive to this type of joint public/private interface to promote a more cost-effective technology transfer capability. **The team recommends that the BRRI RFS Division undertake a systematic search of appropriate national and international NGOs operating**

in Bangladesh for the purpose of devising and entering into collaborative technology transfer working arrangements using the MOU as the formalizing instrument. Donor or other funding agencies should be sought to implement these agreements.

Specific activities to be covered in these collaborative arrangements include: 1) introducing agroforestry, livestock, rice/fish, and postharvest rice technologies for which BRRI has limited staff resources; 2) undertaking or supervising field data collection activities under the supervision of BRRI scientists; and 3) BRRI sponsored practical technology adaptation courses provided at headquarters or district levels.

C. Other Technology Transfer Approaches

1. A "Research Results" Newsletter for Promising Varieties and Technologies

Existing varietal testing programs including ALART, FVOT, and MLT have served and continue to serve as low impact technology transfer mechanisms even though their primary objective is varietal development and testing of cropping technologies under farmer field conditions. These, along with FSR activities, generate much useful knowledge regarding performance of new modern and high-yield varieties under alternative input and rotational practices. Although it reaches the research community through annual reports and professional seminars and workshops, this information is not now reaching farmers, extension personnel, or NGOs in any systematic way. To expand the new knowledge gained from field-level variety development and MLT and FSR trials, **the team recommends that BRRI initiate on a trial basis a quarterly "research results" newsletter targeted primarily toward extension staff, agricultural NGOs, and farming communities. Donor funding should be sought for this purpose.**

The newsletter would report on results of promising new varieties and rotational patterns from ongoing trials and demonstrations. It should not be limited to reporting on approved varieties or "mature technologies." In this way the farming community would be apprised of promising new varieties or technology packages as information is developed. The newsletter would also inform the farming community about upcoming BRRI training activities and field days.

2. Direct Technology Transfer

In at least one instance, BRRI conducted a very effective technology transfer approach with support of top government authorities and the extension service for release of BR-10 and BR-11. These two MVs developed by BRRI now account for over two-thirds of MV T aman grown in the country.

At the time of their development these varieties were considered to be far superior to existing ones. They were released to farmers through a concerted national promotion campaign endorsed by the President and coordinated by the DAE. For its part, BRRI developed sufficient foundation seed to supply local-level DAE officers for distribution to progressive farmers in their jurisdictions. Seed was distributed to these farmers on the

condition that seed from their first year's crop be made available to other farmers in exchange for an equal amount of grain. This farmer-to-farmer seed multiplication approach resulted in widespread national adoption of BR-11 within three years after approval by BRRI scientists. BRRI staff estimated that it would take only 10 metric tons of foundation seed distributed to farmers to carry out a similar program today.

The above experience provides evidence that, with sufficient political will, government outreach and extension agencies can be a very cost-effective way to promote new MV crops.

SECTION V
MANAGEMENT, FUTURE PROSPECTS, CHANGES AND OPTIONS FOR FUTURE IRRI/BRRI COLLABORATION

This section discusses management issues relating to research coordination of BARC within the framework of NARS and coordination of research within BRRI. Personnel and staff management policies are addressed as they relate to BRRI and as they relate to GOB policies over which BARC has no direct control. IRRI/BRRI project performance is reviewed and recommendations made regarding future donor collaboration with BRRI.

A. Research Coordination Mechanisms

The Bangladesh Agricultural Research Council was created by legislation enacted in 1973. The Council is comprised of 28 members representing the civil service and members of the public with interest in agricultural research. The Council is chaired in alternate years by the Minister of Agriculture and the Minister of Livestock and Fisheries. The Executive Committee is headed by an executive vice chairman who represents the secretariat on the Council. The secretariat is commonly referred to as "BARC" and has, over time, taken on de facto executive powers as the Council has found it difficult to meet regularly to address matters of policy and strategy.

While the enabling legislation gives BARC authority to coordinate research in ARIs, it does not control the personnel budgets of the individual member institutions, which include BRRI. Personal emoluments are paid from the Government of Bangladesh development budget. The GOB provides minimal support to research operating costs for ARIs; currently, the GOB contributes just over one-quarter of one percent of agricultural GDP. This is well below the suggested World Bank standard of one percent of agricultural GDP. **It is recommended that the GOB initiate a program to increase funding of operational research costs up to the World Bank standard within the next five years.**

At present, the PL 480 Title III program is the major source of research operating funds which are now managed and administered by BARC. These moneys, received from in-country sales of donated U.S. wheat, are denominated in taka and maintained in a local bank account in the name of the GOB and disbursed by BARC. This gives BARC a degree of leverage over research activities conducted by member institutes.

Previous evaluations, notably that by the International Service for National Agricultural Research (ISNAR) in 1990, have fully documented the problems and shortcomings of the BARC coordination system. A major criticism identified by this team relates to lack of consultation by BARC with member institutes in developing NARS strategic planning documents. Although BARC requests individual institutes to submit prioritized program plans, there appears to be little, if any, feedback from BARC in the process of completing the system-wide planning document. BARC, however, is critical of member

institutes in that they do not develop research priorities as part of the submitted planning documents.

BRRI scientists were also critical of delayed receipt of PL 480 Title III funds from BARC, which is authorized to disburse these moneys to augment operational expenses of member institutes not covered from the GOB development budget. This issue is addressed in greater detail below.

Since the mandate of the team is to review BRRI rather than BARC, we will not venture further comments except to note that there is a general consensus among scientists at BRRI and at BARC that the research and management coordination mechanisms of NARS must be strengthened. From the discussions held with BRRI and BARC over the past few weeks it appears that improvement is possible on both sides. **The team urges both BRRI and BARC to respond more directly to the legitimate needs of the other in developing system-wide planning documents.**

B. USAID and CIDA Program Funding Considerations

BARC has authority to disburse funds based on its review of ARI annual plans submitted by each director general. Both CIDA and USAID now provide funds to BARC for distribution to ARIs. Institute plans rarely provide sufficient prioritization of funding requests to assist in dispersing funds; consequently, BARC often makes decisions based on its prioritization schedule. However, BARC finance and accounting systems are weak and fund disbursement is often delayed. While the team heard considerable misgivings about disbursement delays from both BRRI and BARC, both concur that these funds are the "life blood" of the research system and need to be maintained. **The team concludes that donor funds are crucial to meeting ARI recurrent operating needs.**

1. The U.S. PL 480 Title III Program

Under the PL 480 Title III Program, the value of donated wheat is denominated in taka and maintained in a special GOB account for use in supporting operating expenses of member research institutes. BARC is charged with evaluating annual plans submitted by individual institutions and disbursing funds. Under the operating rules agreed by USAID and the GOB, funds are to be disbursed at six-month intervals subject to submission by the receiving institution of appropriate financial statements within four weeks after the close of the preceding disbursement period.

U.S. PL 480 moneys can be used for casual wages, payment of utilities, purchase of fuel and oil, and for equipment repair. Also covered are travel allowances and per diem, agricultural inputs for experimental plots and for other costs associated with developing experimental plots, books and professional journals, workshops, seminars, farmers' field days, short-term training and purchase of small agricultural implements, computer software, etc. No more than twenty percent of the annual PL 480 budget can be disbursed by BARC for construction of physical facilities without prior approval by USAID. Funds are allocated on a semiannual basis after approval of proposals submitted by ARIs. **It is recommended**

that USAID consider modification of existing regulations to permit vehicle purchase using U.S. PL 480 funds.

Although BARC has authority to disburse PL 480 funds, the Ministry of Finance has reserved its prerogative to review proposed distributions prior to actual transfer to ARI accounts. Moreover, the team heard some reports that these earmarked funds were, at times, temporarily drawn down by MOF for other purposes, further contributing to distribution delays.

Present delays in disbursing PL 480 funds to ARIs undermine the spirit of the law governing the program. To improve fund administration we recommend that:

- **USAID allocate annual PL 480 research operational funds to a revolving account in a private sector international bank doing business in Bangladesh. Fund disbursement to ARIs would be administered by a private sector accounting firm according to a planned schedule based on achieved performance targets.**

- **BARC convene and chair an annual technical program evaluation committee to determine PL 480 funding levels to member institutes. If, after a reasonable period, performance of the evaluation process is not satisfactory, other modalities, including use of an outside contractor, should be investigated.**

2. CIDA Fund Management

Available CIDA research funds do not carry stipulations requiring use of internal GOB financial institutions for funds disbursal. Consequently, CIDA is able to allocate funds directly to each ARI. **CIDA funds for operational research expenditures and equipment can be better managed by making allocations directly to research institutes based on ability to meet objective performance targets.**

C. Adequacy of the BRRI Organizational Structure

The team was requested to review BRRI's organizational structure from the perspective of its impact on research management. Here we comment on aspects of BRRI organization associated with identifying and managing research projects.

BRRI adopted a task force research management approach in 1974 to ensure an interdisciplinary team effort to establish and monitor research programs. As noted in the 1985 review of BRRI Research and Administrative Management Systems: "The use of the task force has proven beneficial in the initial stage....Experience has shown that some task forces are still functioning and have an important continuing role in overall programs such as varietal improvement, pest management, fertilization and cultural practices, farming/cropping systems, and adaptive research and training." (pp. 21-22)

While recognizing the need for changes in the management of research priorities, the above evaluation team suggested moderation and care in changing a system which was still working quite well. Since that evaluation there has been renewed interest on the part of BRRI scientists in re-evaluating the task force research management system.

BRRI administration and professional staff recognize the importance of strengthening present research planning and management functions. However they have been unable to reach a workable consensus solution to both expand the leadership role of mid-level scientists in project development and reserve control and evaluation of the research program for senior management. To assist BRRI in this effort, **the team recommends that IRRI be approached to field a team of research management specialists similar to the 1974 Russell-Minehart-Freeman team which originally developed the task force approach. The role of this team would be to provide on-site facilitation of an improved performance-based research planning and management approach.**

It has been noted in sections III and IV of this report that the role of agricultural economists has become more important in the more applied aspects of BRRI activities. It is consequently suggested that farm production economic analysis be included as an integral part of the Rice Farming Systems (RFS) task force, possibly to be identified as Farming Systems and Production Economics. Similarly, the Agricultural Economics Division is now gathering price information and conducting research on marketing trends and activities which could have future impact on rice marketing policy dialogue. To recognize this, the current Agricultural Economics and Farm Management task force might be suitably identified as the Agricultural Marketing and Policy task force.

Within the context of the planning process there does not seem to be a compelling reason to have a separate task force for regional stations. **As an alternative, it is recommended that regional station heads sit on interdisciplinary task forces for which collaboration from their station is required.** Other regional scientists would then be involved with project-level planning and budget preparation. This approach would provide an objective basis for determining regional station operating budgets.

D. Adequacy of BRRI Research Facilities

1. Adequacy of Headquarters Facilities

The headquarters station at Gazipur has better infrastructure and better equipped laboratories than regional stations, and most of the positions are filled with more highly qualified and experienced scientists. Improvements can nonetheless be made. We list here requests from BRRI staff. These requests deserve serious attention, but the team makes no recommendations as time was insufficient to undertake an item-by-item assessment.

- Construct a training complex and library to enable BRRI to instruct up to 100 trainees at a time.

- About half of the laboratory building is now being used as offices for the administrative and other staff. A new building for administrative staff should be built and/or a new laboratory building should be constructed. At present, laboratory space is at the bare minimum for all disciplines.

- Construction of 120 residential flats is necessary to accommodate the officers and staff. At present about 40 percent of the employees reside in Dhaka and in different places around Gazipur. These people are brought into BRRI daily and taken back to cities by BRRI buses.

- Procurement of scientific equipment, farm machinery, training equipment, office equipment, furniture, and transport has to be made on a priority basis.

- Construction of screened greenhouses for growing newly developed lines will help scientists reduce the length of time required in the breeding process.

2. Adequacy of Regional Station Facilities

In addition to the headquarters station at Gazipur, BRRI has six regional stations located at Comilla, Barisal, Rajshahi, Habiganj, Sonagazi, and Bhanga. Recently 6.5 acres of land were acquired in Rangpur to establish a zonal station there. BRRI has also decided to establish a zonal station at Kushtia to test salt tolerance of MV rice.

In addressing this issue we refer to the 1987 special review of BRRI proposals for Phase III funding by Professors Zillinski and Shebeski. They noted that:

> "Progress achieved by BRRI in developing the regional stations, improving research facilities, providing suitable housing, and maintaining qualified research staff has been *disappointing* (their emphasis). The token support which has been provided to regional stations during the past has very definitely discouraged recruitment of qualified scientists for positions at the stations. The negative attitude of research staff toward regional stations will continue unless a concerted effort by management is made to fully support station development with adequate facilities and staff housing." (p. 35)

The regional stations do not have the required manpower in position, infrastructure development is quite inadequate, and none of the regional stations has the minimum laboratory facilities to even test soil pH or soil salinity. Transport facilities in the regional stations are also poor. However, new vehicles have just been purchased by BRRI, and management anticipates that each regional station will receive new vehicles by the end of 1991.

Social amenities for families in most regional stations are very limited. Except in the Comilla, Barisal, and Rajshahi regional stations, there is very little scope for child education. The brick road constructed by BRRI with Canadian help (about 7 km) was washed away by the sea surge of 1991, making it difficult for the officers and staff of the station to get to the

nearest *upazila* headquarters at Sonagazi proper.

The team observes that facilities have been improved in Habiganj since the previous evaluation, but apart from this little has changed to provide incentives for BRRI scientists to work at regional sites. This is not necessarily the fault of BRRI management: inadequate per diem and lodging allowances and lack of vehicles to conduct necessary field work (including the constant threat that assigned vehicles will be requisitioned by district administrators) are outside the control of BRRI. These issues must be rectified by GOB. Similarly, BRRI is prevented by government personnel policies from paying inducement or hardship allowances which could compensate, at least in part, for poor living and working conditions. These issues must be addressed at the level of BARC and should be placed on the agenda for any future evaluation to improve the NARS coordination and management capability.

Basic needs remain to be met at BRRI headquarters and the outlying regional stations. The needs are more acute and urgent for the regional stations; scientists should live more comfortably and work in the stations and farm fields with sufficient supportive facilities and equipment.

Improving the professional environment by providing or upgrading library and computer facilities and other research equipment, and by providing recreational facilities in the more remote sites are within the scope of BRRI management (albeit with donor assistance). Moreover, BRRI management should investigate the provision of housing in urban areas for scientists at research stations such as Sonagazi, which is in a very isolated location. **The team recommends that CIDA and USAID managers investigate and work with BRRI to improve research facilities and housing for scientists at remote stations. Actions which are within BRRI ability to address include:**

- **Fill existing vacant positions at regional stations.**
- **Give priority preference for foreign training to scientists who have worked or are working at regional stations.**
- **Enforce a minimum three years' service at regional stations as a prerequisite for promotion.**
- **Make a roster and take steps to transfer scientists and staff to regional stations by rotation as a matter of routine so that such transfers are not considered punishment.**

E. Personnel Incentive Issues

Discussions with BRRI and BARC officials indicated that improvements in the research planning and priority setting process could be made. The lack of involvement in research planning processes by all but the most senior scientists at headquarters level was conveyed to the team. Moreover, we believe that introduction of a more participatory

research planning approach may improve morale and productivity of mid-level and regional station staff who now feel almost completely outside the decision making process.

Most issues affecting staff morale are beyond the scope of BRRI management. As with many other issues addressed in this section, morale issues have been recognized by previous evaluation teams, and are all too painfully obvious to BRRI scientists.

At its inception BRRI and other ARIs enjoyed a higher salary scale than did employees under the government revenue budget. Over time this differential was eliminated. Without access to the government pension provisions, ARIs cannot compete for qualified employees. The original purpose of their autonomous status was to recognize that scientists require compensation commensurate with their professional training and increased job expectations.

While the current structure guarantees research management a modicum of operational autonomy, BRRI management is unable to grant promotions to officers without concurrence of BARC, which has responsibility for reviewing promotions in all research institutes within NARS. The power to grant promotions would be better located with the individual ARIs, with the concurrence of their respective Boards of Governors.

ARI employees receive only a lump sum gratuity on retirement. They are not entitled to pensions, as are civil servants. Parliament approved legislation several years ago providing pension parity with civil servants, but it has not yet been implemented. These provisions should be implemented as soon as possible.

Mandatory retirement age for ARI staff is 57 years. Colleagues in the university system do not face mandatory retirement until age 60. Forced retirement at an early age can result in the loss of valuable, experienced, professional manpower.

Given the limited number of administrative posts available within a research organization, BRRI management has proposed a system of in-situ promotions to reward outstanding scientific achievement on its own merit. It has been submitted to BARC but action has not yet been taken. In-situ promotions are used by research institutions outside of Bangladesh and by universities within Bangladesh to provide in-grade promotions to productive senior scientists. It should be seriously considered by relevant GOB authorities.

A major deterrent to conducting field work away from duty stations is the abysmally low lodging and per diem allowances for scientific officers. Junior officers receive lower allowances than senior officers, creating additional disenchantment among the former. Housing and transport allowances also have not been updated to reflect current costs of living. House rental ceilings, lodging, per diem, medical, and conveyance allowances should be improved to reflect current cost structures.

Associated with low travel allowances are GOB regulations limiting imports of vehicles for field use and the attendant propensity of local administrative officials to expropriate vehicles for special uses. It appears that most regional staff anticipate that their

vehicle will be used by local government officials an average five days per month. Reports of vehicles being commandeered for two weeks or more were encountered in the course of discussions. Without changes in national legislation, vehicles with public registrations will remain subject to requisition. **However, donors are urged to take steps to ensure that vehicles provided with donor funds be treated as non-Bangladeshi government vehicles to guarantee their use for the intended purposes.**

Research scientists such as those at BRRI are an invaluable national asset. Their work has made it possible for Bangladesh to become almost self-sufficient in rice production over the past 20 years despite annual population increases averaging 2.5 percent or higher. Similar expertise and dedication is required over the next 20 years, during which time the population may again increase to over 175 million from the current 115 million. Most of the personnel and management issues addressed in this subsection are beyond the scope of BRRI management. Some are beyond the scope of BARC or the NARS. But the effects of GOB inaction devolve to BRRI, which in recent years has lost several promising young scientists, and which has been unable to fill these vacancies with suitably qualified and motivated replacements. **The team recommends that the GOB act with extreme urgency and dispatch to address all outstanding personnel and related issues within the context of the entire agricultural scientific community in Bangladesh.** If resolution of these pressing issues is not achieved in the next few years, an entire generation of scientific expertise may be forever lost as qualified scientists turn to more rewarding endeavors.

F. CIDA and USAID Project Management Issues

The IRRI/BRRI project supports BRRI institutional development. The present phase of the IRRI/BRRI project was scheduled for completion in November 1991 but will be extended to June 1993. At one time, up to five expatriate technical assistance (TA) staff were supplied under the collaborative agreement. Only two TA staff are now provided: an FSR specialist and a research systems specialist. The latter also serves as project leader and IRRI representative. The FSR specialist will be completing his contract in December 1991. The research systems specialist will remain through the project extension period. The TA staff are employees of IRRI and operate under an MOU between IRRI and BRRI.

TA staff are employees of IRRI but are paid from funds provided by the project. USAID funds have been used primarily for this purpose and for degree training. CIDA funds primarily support equipment procurement, short-term training, networking, and building construction.

IRRI, as a specialized rice research institute, is a reservoir of technical knowledge for BRRI and serves as a conduit through which country-specific and regional mini-projects are implemented. Project funds can also be used to purchase vehicles and other commodities. Coordination of long- and short-term training for BRRI scientists is done through the project.

Mini-projects are planned and implemented with the assistance of the in-country IRRI representative and are usually funded with specially targeted moneys from multilateral donor sources. At present, IRRI/BRRI are collaborating on more than ten such mini-projects.

Quarterly reports are submitted to CIDA, USAID, and IRRI. Financial statements for the preceding quarter are included as part of each report. The IRRI TA team prepares quarterly reports of progress for each collaborative mini-research project. The current reports are well written and provide much useful information on work in progress and work completed. Relating work in progress and work completed to identified objectives and targets could improve their usefulness as a management tool.

The team is not aware of any major outstanding issues regarding project implementation. Close coordination between project staff and donor representatives is being maintained. The following suggestions were made during our conversations with project representatives:

1. Quarterly reports prepared by the TA team can be improved as a management tool by:

- **Issuing the report three times per year to more closely coincide with the three rice planting seasons.**
- **Providing a brief summary for each mini-project describing progress toward meeting project objectives and problems encountered, if any.**
- **Identifying ways to address implementation problems and determine what assistance is needed.**
- **Reducing length and improving organization of reports, using appendices where background information is needed to support main points.**

Using the above approach, the regular periodic reports will most likely be no longer than ten pages each.

2. USAID and CIDA project management officials should travel more often to project field sites to gain a greater appreciation of results obtained and difficulties encountered.

G. Future Potential Donor Support for BRRI Development

BRRI is now a mature research institute. It has a demonstrated record of accomplishment and a good complement of professional and support staff. Unfortunately, existing personnel incentives under the control of the GOB do not recognize the special role which BRRI has played in development of MV and HYV rice. Because of their expertise, BRRI scientists fit well into the research programs of other countries. Reports reviewed by the team suggest that the drain of these highly qualified professional staff to foreign countries and to other jobs has increased in the past few years. As a result, the expansion of BRRI positions beyond present numbers does not appear to be a priority over the next five years. Rather, the challenge is one of maintaining and improving the current standard of excellence by providing sufficient incentives for outstanding young scientists to remain with the institute

and replacing scientists who retire or leave for other reasons with equally good or better personnel.

Providing advanced degree training based on merit and introducing improvements in planning and prioritizing the research agenda to bring mid-level scientists into the research planning process may be ways to achieve this objective.

Field-level adaptive and applied research, already at a high level, can be improved by placing additional emphasis on farm-level production economics studies as part of the whole farm systems research program. This is needed to develop additional knowledge supporting commercial development of small-scale rice farmers. Additional emphasis on marketing and rice policy research can also strengthen the ongoing research program.

The team anticipates that technology transfer activities now concentrated primarily in the public sector will increasingly be transferred to the private sector. Commercial seed growers and NGOs will most likely become important disseminators of BRRI-developed technologies. **Closer linkages with these sectors should be established; some donor support may be needed in this effort.**

A continued lack of operational research funding and restrictive transport policies will severely hamper future BRRI research activities in the event that USAID and CIDA funding is withdrawn completely after June 1993. Future project support from USAID and CIDA is needed to provide research operating funds, including purchase of vehicles, equipment, and buildings. Modalities need to be developed for fund allocation directly to individual research institutes which resolve or bypass existing GOB financial management and accounting bottlenecks, and which are based on the ability of the institute to meet objectively determined research targets.

Continued professional interaction with IRRI in a cooperative partnership relationship such as those now in effect in countries such as Thailand and Indonesia should be continued after termination of the present project. **One in-country IRRI representative, supported by IRRI core funds, should be provided at the close of the current project to continue the formal liaison between IRRI and BRRI.** At this time BRRI does not anticipate that TA is necessary as part of a follow-on project, but in the future specialized assistance in emerging areas such as biogenetic engineering may be needed.

BRRI, USAID, and CIDA personnel all expressed strong concerns that IRRI should conduct more short term in-country training of BRRI scientists. This would be far more cost-effective and can have greater impact than only following a program of sending BRRI scientists to IRRI. The team supports these suggestions.

Since organization in 1973, BRRI has served the nation well with a dedicated basic research program concentrated quite heavily on developing medium-input MVs for adaptation by resource-poor small farmers. These varieties provide increased yields over existing LVs grown under the same input use and management levels. This has been an appropriate

orientation and will remain so to meet the needs of resource poor farmers whose numbers are likely to increase in the future. **However, an additional priority effort is required by BRRI plant scientists to develop sustainable, disease-resistant and input-efficient high-yielding varieties primarily for growth under irrigated boro conditions to meet anticipated nutritional needs of projected population growth.** Farmers using these varieties will initially be the commercial or semicommercial farmers, regardless of size, who are able to realize income gains from increased fertilizer applications and better management.

ANNEX A
SCOPE OF WORK
BRRI/IRRI PROJECT EVALUATION

A. Activity Identification

The activity to be evaluated is BRRI/IRRI Rice Research and Training, USAID project No.388-005103, CIDA project No.170/08004. The task is to carry out a mid-term progress evaluation. This evaluation is undertaken jointly by USAID and CIDA.

B. Evaluation Purposes

The purposes of this evaluation are:

1. To enable USAID, CIDA, and the GOB to assess project progress and performance in terms of strengthening BRRI's institutional capacity to develop and deliver relevant research findings to farmers.

2. To enable USAID, CIDA, and the GOB to assess in detail the results achieved and impact of activities within each of the three major areas of activity funded under the project.

3. To assist USAID, CIDA, the GOB, BRRI, and IRRI to identify those short- and medium-term changes to project strategy, areas of focus, and implementation activities which are essential to the improvement of project performance.

C. Background

The BRRI/IRRI Rice Research and Training project was established in 1975 with funding from the Ford Foundation and the Governments of Australia and Canada (CIDA). Phase II of the project began in 1981, with USAID involvement in the consortium of donors. Phase III of the project began in January 1988, with funding through June 1991 from USAID ($2 million) and CIDA ($1.40 million). Donors and the GOB have agreed to extend the project through June 1993, with additional USAID funding of $670,000. Project assistance is intended to strengthen BRRI's institutional capacity to develop and deliver relevant research findings to farmers by: 1) facilitating collaborative research and training among BRRI and IRRI scientists; 2) training and developing the professional competence of BRRI scientists; and 3) obtaining scientific equipment, supplies, machinery, and vehicles. USAID assistance focuses on providing IRRI scientists support and manpower training, and is funded under its overall Agricultural Research II project. CIDA provides assistance primarily in the areas of equipment, supplies, and facilities improvement and manpower training, and also supports international travel and limited funding for scientist support.

34

BRRI-IRRI collaboration operates under a Memorandum of Understanding for technical assistance and professional cooperation in research and training on rice and rice farming systems. The overall project purposes are: 1) to increase rice production and make the country self-sufficient in rice by developing improved varieties that are suitable for the various growing conditions in the country; 2) to develop and field test technologies that are economically appropriate; and 3) to assist agencies and organizations working with farmers to implement improved rice production technologies. Prior to 1987, five IRRI scientists were assigned to BRRI; since March 1987, two IRRI resident scientists, a representative/systems research specialist and a cropping/farming systems agronomist, are working at BRRI.

The project was evaluated by USAID in 1985. The external evaluation of the overall ARP II project in 1987 also assessed progress under the IRRI/BRRI project. Project progress will also be examined as part of the USAID overall evaluation of its Agricultural Research II project scheduled for May-June 1991.

D. Statement of Work

The evaluation shall assess project progress in strengthening BRRI's institutional capacity to develop and deliver relevant research findings to farmers; examine specific results and impacts achieved under each major area of assistance; review the factors that have affected project achievements; and provide specific, prioritized, and actionable recommendations for the remainder of the project period and for the longer term.

The evaluation shall examine performance of the project and provide recommendations in relation to each of the three project purposes identified above by addressing the following key areas and questions:

1. Assess the Effectiveness Of IRRI/BRRI Project Activities In Increasing Rice Production By Developing Improved Rice Varieties Suitable For The Various Growing Conditions In The Country

a. How many new improved rice varieties have been developed and/or released as a result of BRRI/IRRI collaboration? What proportions of Aman, Boro, and Aus crop production are accounted for by BRRI varieties?

b. To what extent are the varieties developed by BRRI acceptable to and adopted by farmers? What evidence is there that these varieties have resulted in increases in farm production, yields, and net income?

c. Is regional rice research appropriately based on Bangladesh's agroecological conditions?

d. Is collaborative research an effective mechanism to achieve varietal improvement relevant to Bangladesh's requirements?

e. Is the varietal improvement program appropriately focused? Does allocation of resources (i.e., funds, manpower, equipment, etc.) match priorities?

f. What were BRRI's major accomplishments in relation to the specific plans and targets included in the Third Five-Year Plan for rice and rice-based cropping systems research? What were the factors influencing results?

g. Is there a monitoring system in place for BRRI to review the quality, progress, and results of research?

h. What mechanisms are in place to provide for the management/ maintenance/improvement of technologies for varieties, once developed?

i. Are U.S. PL 480 funds a significant factor in research effectiveness and what improvements, if any, are needed in management of U.S. PL 480 funds for rice research?

2. Assess the Effectiveness Of BRRI/IRRI Project Activities In Developing and Field Testing Technologies That Are Economically Appropriate

a. What are the number and nature of new technologies developed and released in the areas of cropping systems and production practices (e.g. water management and postharvest technology)?

b. What new technologies have been developed by rice farming systems research? What new technologies are in the pipeline and how do these relate to farmers' identified needs?

c. What are the specific economic benefits of farming systems research produced by the three FSR sites? What evidence is there that these technologies are being adopted and are resulting in increased production, yields, and income gains? Are there other benefits?

d. Is rice farming systems research contributing significant information and technologies to other research disciplines?

e. Is the manpower in place relevant to research requirements? Is the training strategy effective in meeting manpower needs to carry out research requirements? Are personnel policies and procedures effective in promoting job satisfaction and sound research?

f. Are the research stations and FSR sites equipped with the essential infrastructure, equipment, and supplies necessary to conduct relevant research? Analyze/compare their adequacy in relation to research requirements.

3. Assess The Effectiveness Of BRRI/IRRI Project Activities In Assisting Agencies And Organizations Working With Farmers To Implement Improved Rice Production Technologies

a. What are the specific technology dissemination mechanisms in use and are these working effectively to extend the technologies developed?

b. How effective is the organized group training conducted on FSR sites?

c. To what extent is multilocation testing of rice technologies carried out by Department of Agricultural Extension and how effectively has multilocation testing served to transfer improved technologies?

d. How effective are the linkages of BRRI/IRRI with other government, nongovernment, and private agencies involved with technology transfer and information dissemination?

4. Assess Management, Future Prospects, Necessary Changes And Options For BRRI/IRRI Collaboration

a. Is BRRI well-served by BARC in relation to technical services and research cooperation?

b. Is BRRI's organizational structure appropriate to serve rice research requirements and what changes, if any, are needed?

c. Are USAID and CIDA project management and donor coordination effective and what changes, if any, are needed?

d. Are BRRI/IRRI collaboration and implementation mechanisms working effectively and what changes, if any, are needed?

e. What is the potential of BRRI to assume greater management control of administration, procurement, and related functions associated with the project?

f. What changes or adjustments should be made to project strategy, areas of emphasis, or major implementation activities in order to complete project purposes by June 1993?

g. To what degree are the institutional improvements and research developments achieved under the project sustainable?

h. Should the BRRI/IRRI project be extended beyond 1993? If so, which areas of support should receive emphasis, and why?

ANNEX B
EVALUATION METHODOLOGY

Initial briefing meetings were held with the Office of Food and Agriculture program, project officers of USAID, and the First Secretary (Development), CIDA. General briefing sessions with BRRI and the technical assistance team from IRRI were also held at the start of the review process. Field visits were made to regional research stations at Comilla and Rajshahi, where research officers were interviewed and facilities inspected. Poor weather conditions forestalled visits to other regional stations.

The team also met with the executive vice chairman of BARC and several member/directors to gain their perspective on research coordination issues. An in-depth discussion with the Ministry of Agriculture joint secretary for planning provided many insights into research and related issues under review by that ministry. The director general of Agriculture Extension provided perspective on research/extension coordination issues. Discussions with BARI officers responsible for conducting the on-farm research program of that institute provided the team with comparative information on research programs similar to those operated by BRRI. Although visits were planned with officers at the Bangladesh Institute of Nuclear Agriculture (BINA) and the Bangladesh Agricultural University (BAU), these were not completed due to insufficient time.

General discussions were held with team members of donor projects impacting on BRRI research and technology transfer activities. These included the CIDA-supported Agricultural Sector Team and Crop Diversification projects, and the USAID-supported Agricultural Research project (supplement).

Individual team members then held in-depth interviews with selected BRRI officers and the IRRI team leader to gain additional information and insights into the program of the institute and the IRRI/BRRI project. The FSR site at Sreepur was visited. Farming systems research activities were closely reviewed and assessed by the agricultural economists on the team. The crop scientists on the team closely reviewed and assessed the plant breeding and varietal development aspects of the BRRI program.

Throughout the evaluation period the team reviewed all pertinent literature made available to it regarding rice varietal development and technology transfer activities.

Several debriefing sessions were held at the close with donor and BRRI staff and with the IRRI technical assistance team.

ANNEX C
HISTORY OF AGRICULTURAL RESEARCH AND DEVELOPMENT OF BANGLADESH RICE RESEARCH INSTITUTE

The Indian Department of Agriculture was established in 1905 and the Bengal Department of Agriculture in 1906. Systematic agricultural research, particularly on rice, started in 1908 in what is now Bangladesh, when a nucleus agricultural research laboratory was established in Dhaka to serve the provinces of Bengal and Assam. At about this time a 163 ha experimental station was set up and became known as the Dhaka Farm. There were 17 persons on the scientific staff in 1925 to conduct research on rice, jute, cotton, sugarcane, pulses, and oilseeds. Another important step was establishment in 1929 of the Imperial Council of Agricultural Research (ICAR) in India on the recommendation of the Royal Commission on Agriculture (1926-1928). ICAR coordinated the activities of the central research institutes and the state research centers.

Considering the importance of education in the field of agriculture, the Bengal Agricultural Institute was established in 1938 as the only school for higher education in agriculture in the province. This is now the Bangladesh Agricultural Institute, affiliated with the Bangladesh Agricultural University and administered by BARI.

With the departure of the British in 1947, the ICAR was divided into the Indian Council of Agricultural Research and the Food and Agricultural Council of Pakistan. Both councils had similar purposes to undertake, aid, promote, and coordinate agricultural research in their respective countries.

Old research institutes in jute, tea, and sugarcane were lost to India at the time of partition. New research agencies were established to conduct research in jute and sugarcane in 1951. These agencies later became Bangladesh Jute Research Institute (BJRI) and Sugarcane Research and Training Institute (SRTI). The Pakistan Tea Research Station established in 1958 was later renamed the Bangladesh Tea Research Institute (BTRI). The Forest Research Institute (BFRI) was established in 1955. The Agriculture Research Institute (now Bangladesh Agricultural Research Institute, BARI) was established in 1957 under the Directorate of Agriculture (Research and Education).

The Atomic Energy Agricultural Research Centre established in Dhaka in 1961 with assistance from the International Atomic Energy Agency was then separated from the Bangladesh Atomic Energy Commission to become an autonomous organization as the Bangladesh Institute of Nuclear Agriculture in 1975, located at the BAU campus at Mymensingh.

The BAU was established in 1962 as the only university to offer higher education in agricultural sciences and an advanced research program. Also in 1962, the Dhaka Farm was

taken over by the government to build the second capital of Pakistan without making any alternative arrangement for transferring the equipment and the collection of rice germplasm; the germplasm collected over a period of 50 years was lost consequently.

Reorganization of agricultural research continued during the sixties. The Pakistan Agricultural Research Council was formed from the Food and Agriculture Council in 1964.

The International Rice Research Institute introduced the first HYV rice into Bangladesh in 1965. Sugarcane varieties were imported for testing on mill farms, and Virginia tobacco was imported, finally becoming the dominant tobacco.

A. Achievements of BRRI

1. National

Although rice research started in 1908, there was no real breakthrough until 1970. In 1970, the first BRRI modern variety, BR-1 (*Chandina*) was released with average yields of 4.5 to 5.5 t/ha. From 1970 to 1991, 26 BRRI modern varieties have been released through the National Seed Board. The last 2 varieties (BR-22 and BR-23) are photoperiod sensitive and suitable for late planting after the recession of flood water. There are about 8 more advanced varieties in the pipeline. Three more varieties (two for Broadcast aus and one for Transplant aman) have been proposed to NSB for approval. The modern varieties occupy about 32 percent of total rice area and produce about 50 percent of the total rice harvest in the country.

The proportion of aman, aus, and boro crop production accounted for by BRRI varieties in 1990 are:

	Aman (%)	Aus (%)	Boro (%)
Total MV contribution	66	43	93
BRRI varieties	55	37	66
Total LV	34	57	07

About 14 new profitable rice-based cropping patterns have been developed for different agroecological zones. An animal-driven pump has been developed at BRRI which can utilize idle cattle power during off times of the year. It can lift about 170-225 litres of water per minute from a depth of 3-7 meters. BRRI has recommended effective and balanced fertilizer applications for different rice growing areas. Remedial measures have also been suggested for S and Zn deficient areas (about 4.0 million ha).

BRRI received six national awards between 1976 and 1986. These were:

- President's Gold Medal for Agriculture to BRRI Varietal Improvement Group (1976).

- President's Gold Medal for Science and Technology to the director general, BRRI (1978).

- FAO Bronze Plaque to BRRI for developing BR-10 and BR-11 (1980).

- President's Gold Medal in Agriculture to Agril. Engineering Division for developing a diaphragm pump (1980).

- President's Gold Medal for Agriculture to Plant Pathology Division (1984).

- Gold Medal from Begum Zebunnessa and Kazi Mahbubullah Trust to a group of six breeders (1986).

2. International

BR-11 produced the highest yield of 15 t/ha of paddy in Mexico in 1975. The trials were coordinated by the IRRI.

A number of BRRI varieties and breeding lines were officially released in different countries of the world. These are as follows:

- BR-1 (*Chandina*) in India and Nepal
- BR-2 (*Mala*) in India, and Nepal by the name of Mallika
- BR-3 (*Biplab*) in Vietnam
- BR-4 (*Barrisail*) in India as Radha and in Burma as Sinthingi
- BR-51-282-8 in West Africa
- BR-51-46-1-C in India
- BR-153-3710-3-1-2 in Bhutan

BR-10 and BR-11 were not released in West Bengal (India) but these two varieties are grown extensively there.

Ufra disease in rice is a major constraint on production in Bangladesh, India, Burma, Thailand, and Vietnam. BRRI was the first institute to develop a method to search for resistance when screening different rice varieties under field conditions. IRRI has adopted this method and is using it to conduct international rice ufra screening trials in all the above countries.

C. The National Agricultural Research System (NARS)

In 1973 an important decision was taken (Presidential Order No.32) to establish the Bangladesh Agricultural Research Council. BARC was established to plan, coordinate, and evaluate the activities of agricultural research institutes. Also in 1973, HYVs of wheat from the International Research Center for Maize and Wheat were introduced into Bangladesh.

Due to the increase in the number of research institutes with broader terms of reference, the BARC Ordinance was amended in 1976 to give greater authority to coordinate and provide leadership to the NARS. The same year BARI was reorganized as an autonomous institute, dissolving the Directorate of Agriculture (Research and Education).

The formal organization of the agricultural research system was almost complete by the end of the 1970s. BARC, BRRI, and BARI were autonomous institutes; BJRO, SRTI, BINA and BTRI were semiautonomous organizations.

After the various research and educational organizations were formally organized, construction of new facilities started. Some organizations have good infrastructure. BRRI was one of the first to be housed in a new facility at Gazipur, where construction for BARI was also initiated along with its four regional stations. BARC headquarters were built in Dhaka. These facilities were developed with help from USAID and the World Bank. Australia helped with construction of SRTI, Japan with the Citrus and Vegetable Research Centre of BARI, and Great Britain with BJRI. The College of Agricultural Sciences was created as a part of BARI in 1983 at Salna near BRRI. This was converted into the Institute of Postgraduate Studies in Agriculture (IPSA) in 1986. It is now an autonomous organization outside the domain of BARI.

There now exist a number of research institutes which form a network of agricultural research in the country. They are:

(1) The Bangladesh Agricultural Research Institute (BARI)
(2) The Bangladesh Rice Research Institute (BRRI)
(3) The Bangladesh Jute Research Institute (BJRI)
(4) The Bangladesh Livestock Research Institute (BLRI)
(5) The Bangladesh Forest Research Institute (BFRI)
(6) The Bangladesh Tea Research Institute (BTRI)
(7) The Bangladesh Institute of Nuclear Agriculture (BINA)
(8) The Fisheries Research Institute (FRI)
(9) The Sugarcane Research and Training Institute (SRTI)
(10) The Soil Resources Development Institute (SRDI)

The main function of BAU is to provide university-level training in agricultural science and to conduct basic, applied, and adaptive research in various branches of agriculture.

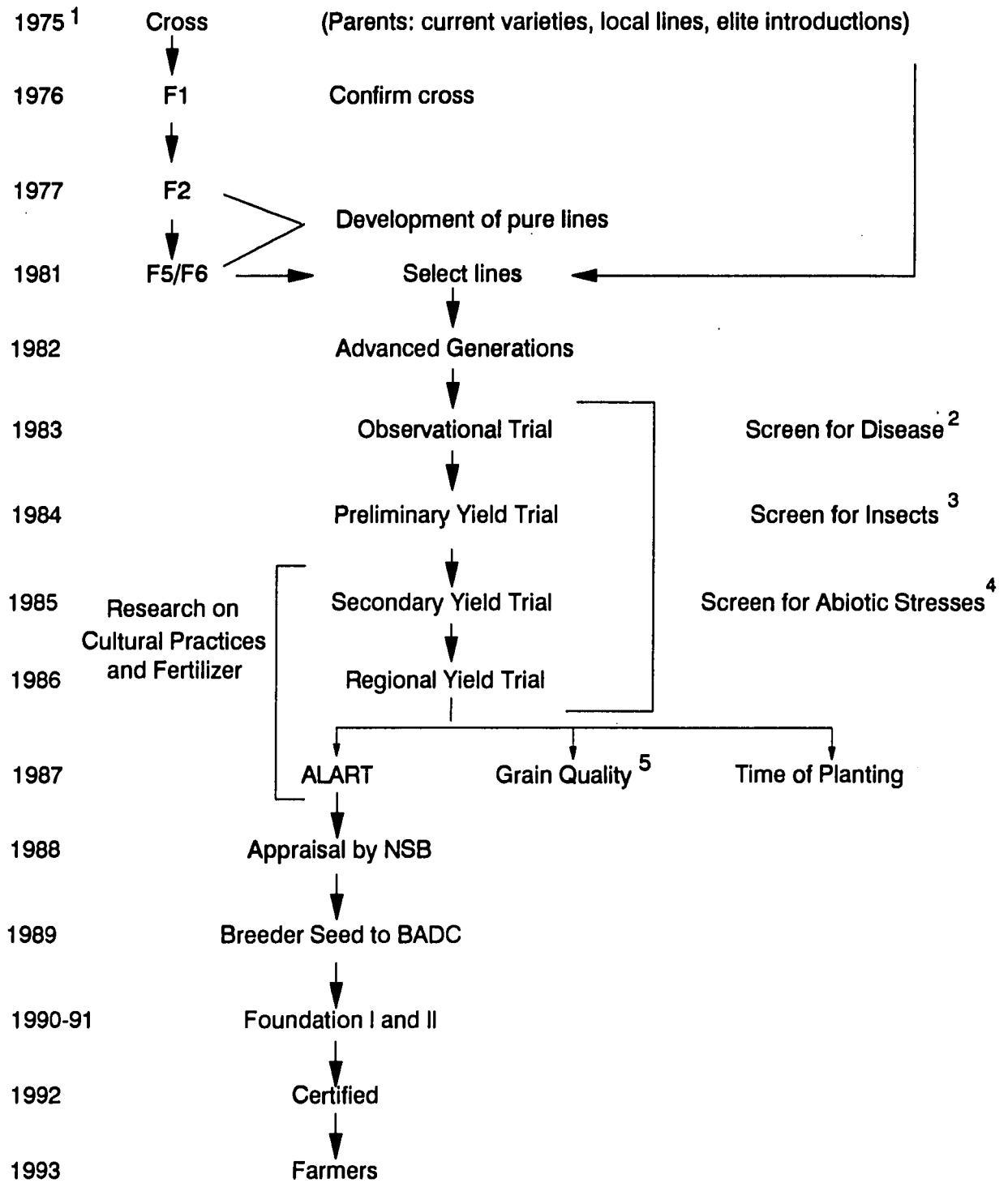
BRRI, SRTI, BTRI, and BJRI are monocrop institutes, and BARI, BINA and BFRI are multicrop research institutes. Socioeconomic research related to agriculture and rural development is carried out by the Bangladesh Academy for Rural Development (BARD), the Bangladesh Institute of Development Studies (BIDS), and the BAU.

92

ANNEX D
SCHEMATIC OF BRRI PLANT BREEDING PROGRAM

Figure 1. Varietal Improvement Program

ANNEX D



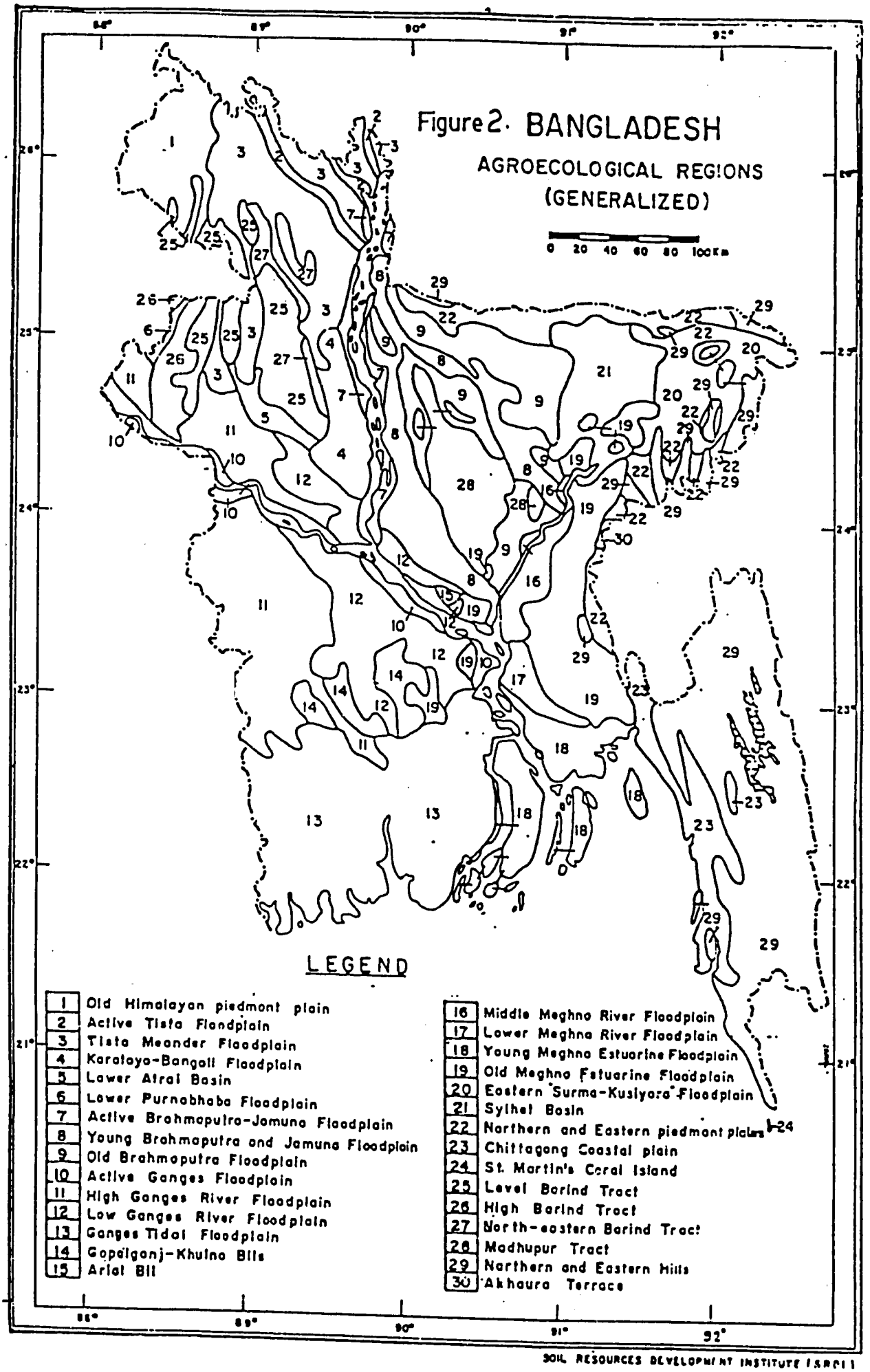
1 Dates given are for the variety BR-22 (Kiron)

2 Diseases screened: Rice Tungro Virus (RTV), Bacterial Leaf Blight (BLB), Blast (BL), Sheath Blight (ShB), Stem Rot (SR), Sheath Rot (ShR), Leaf Scald (LSc)

3 Insects screened: Brown Plant Hopper (BPH), Green Leaf Hopper (GLH), White Backed Planthopper (WBPH)

4 Abiotic stresses screened: cold, submergence, drought, photoperiod, high temperature

5 Brown rice out-turn (%), size and shape, endosperm appearance, milled rice appearance, 1000 grain weight (g), amylose (%), protein (%)



SOIL RESOURCES DEVELOPMENT INSTITUTE (SRDI)

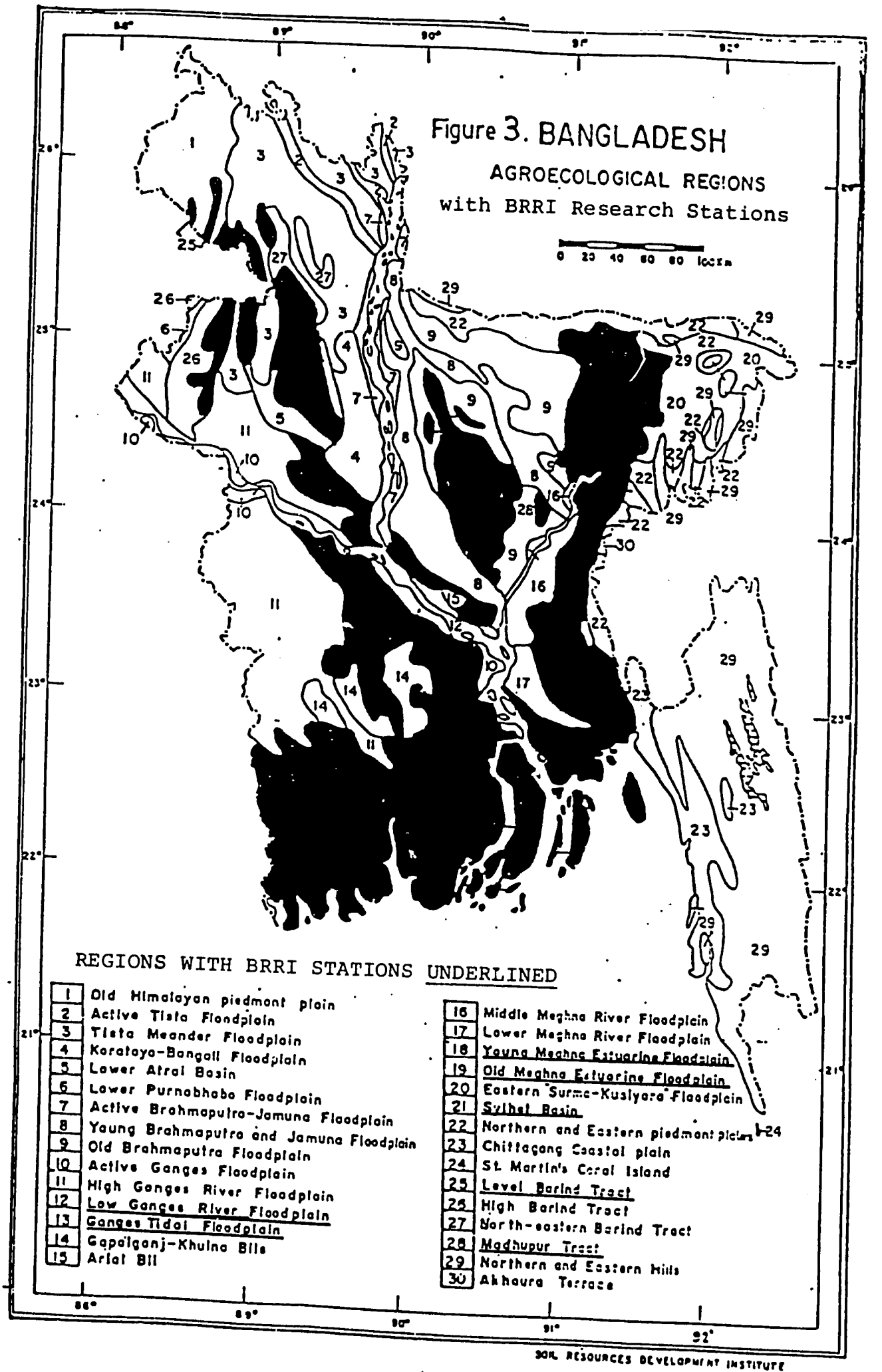


Figure 3. BANGLADESH
AGROECOLOGICAL REGIONS
with BRRI Research Stations
0 20 40 60 80 100km
REGIONS WITH BRRI STATIONS UNDERLINED
1 Old Himalayan piedmont plain
2 Active Tista Floodplain
3 Tista Meander Floodplain
4 Karatoya-Bangali Floodplain
5 Lower Atrai Basin
6 Lower Purnabhaba Floodplain
7 Active Brahmaputra-Jamuna Floodplain
8 Young Brahmaputra and Jamuna Floodplain
9 Old Brahmaputra Floodplain
10 Active Ganges Floodplain
11 High Ganges River Floodplain
12 Low Ganges River Floodplain
13 Ganges Tidal Floodplain
14 Gopalganj-Khulna Bils
15 Arial Bil
16 Middle Meghna River Floodplain
17 Lower Meghna River Floodplain
18 Young Meghna Estuarine Floodplain
19 Old Meghna Estuarine Floodplain
20 Eastern Surma-Kushiyara Floodplain
21 Sylhet Basin
22 Northern and Eastern piedmont plains
23 Chittagong Coastal plain
24 St. Martin's Coral Island
25 Level Barind Tract
26 High Barind Tract
27 North-eastern Barind Tract
28 Madhupur Tract
29 Northern and Eastern Hills
30 Akhaura Terrace
SOIL RESOURCES DEVELOPMENT INSTITUTE

Table D-1. Area and yield of local and modern varieties of aus paddy in Bangladesh, 1959-1989.

Year	Area (ha)			Yield (m ton/ha)		
	Total	Local	MV	Total	Local	MV
1959	2284651	2284651	0	1.04	1.04	
1960	2405811	2405811	0	1.33	1.33	
1961	2549553	2549553	0	1.49	1.49	
1962	2376958	2376958	0	1.49	1.49	
1963	2505645	2505645	0	1.34	1.34	
1964	2665088	2665088	0	1.52	1.52	
1965	2689086	2689086	0	1.42	1.42	
1966	2962491	2962491	0	1.50	1.50	
1967	2818453	2818453	0	1.45	1.45	
1968	3326980	3326980	0	1.41	1.41	
1969	3098972	3092295	6677	1.31	1.32	5.35
1970	3424279	3406904	17375	1.30	1.32	4.93
1971	3190866	3158543	32324	1.33	1.37	5.01
1972	3001876	2953017	48859	1.14	1.19	4.10
1973	2930191	2863925	66266	1.12	1.18	3.83
1974	2986950	2853744	133206	1.29	1.43	4.36
1975	3186710	2903938	282773	1.14	1.37	3.74
1976	3422510	3069520	352991	1.18	1.44	3.70
1977	3214659	2849864	364795	1.17	1.43	3.45
1978	3162523	2765386	397137	1.21	1.49	3.47
1979	3397378	2970772	426606	1.19	1.47	3.43
1980	2912019	2509623	402396	1.15	1.42	3.12
1981	3151864	2666270	485593	1.24	1.52	3.04
1982	3145830	2674159	471671	1.26	1.56	3.25
1983	3184816	2683034	501783	1.17	1.45	2.97
1984	3098203	2638782	459421	1.26	1.48	2.78
1985	2959182	2472278	486905	1.16	1.44	2.86
1986	2844933	2363166	481767	1.21	1.49	2.87
1987	2902664	2359799	542855	1.39	1.63	2.67
1988	2788511	2290401	498110	1.40	1.63	2.68
1989	2078670	2266779	411891	1.43	1.61	2.62

Table D-2. Area and yield of local and modern varieties of aman paddy in Bangladesh, 1959-1989.

Year	Area (ha)			Yield (m ton/ha)		
	Total	Local	MV	Total	Local	MV
1959	5320060	5320060	0	1.42	1.42	
1960	5782607	5782607	0	1.58	1.58	
1961	5899478	5899478	0	1.70	1.70	
1962	5698798	5698798	0	1.78	1.78	
1963	5754927	5754927	0	1.60	1.60	
1964	5913965	5913965	0	1.88	1.88	
1965	6112420	6112420	0	1.81	1.81	
1966	5929343	5929343	0	1.75	1.75	
1967	5689369	5689369	0	1.58	1.58	
1968	5941310	5941310	0	1.75	1.7[illegible]	
1969	5827433	5827433	0	1.80	1.80	
1970	6005908	5994106	11802	1.76	1.76	4.75
1971	5740083	5659212	80871	1.56	1.53	3.64
1972	5370709	5117563	253146	1.62	1.49	4.19
1973	5714210	5156317	557893	1.49	1.36	2.68
1974	5719240	4892487	826753	1.78	1.47	3.61
1975	5451841	4950433	501408	1.68	1.52	3.25
1976	5791162	5206192	584970	1.85	1.71	3.15
1977	5809174	5385808	423366	1.81	1.70	3.23
1978	5689926	5191223	498703	2.04	1.90	3.51
1979	5807792	5112175	695617	1.95	1.77	3.31
1980	5948303	5077647	870657	1.87	1.68	2.99
1981	6034986	5075404	959583	1.98	1.74	3.24
1982	6011015	5055471	955544	1.81	1.64	2.71
1983	5996283	4920543	1075740	1.87	1.66	2.85
1984	6007538	4943940	1063598	1.98	1.79	2.89
1985	5714269	4634345	1079924	2.08	1.85	3.07
1986	6032890	4859571	1173320	2.12	1.88	3.11
1987	6053217	4804745	1248472	2.05	1.79	3.03
1988	5569212	4372000	1197212	2.07	1.80	3.07
1989	5065108	3710977	1354131	2.03	1.73	2.86

Table D-3. Area and yield of local and modern varieties of boro paddy in Bangladesh, 1959-1989.

Year	Area (ha)			Yield (m ton/ha)		
	Total	Local	MV	Total	Local	MV
1959	344563	344563	0	1.73	1.73	
1960	371090	371090	0	1.64	1.64	
1961	407632	407632	0	1.67	1.67	
1962	407511	407511	0	1.81	1.81	
1963	433572	433572	0	1.69	1.69	
1964	432682	432682	0	1.79	1.79	
1965	423702	423702	0	2.05	2.05	
1966	460236	460236	0	2.04	2.04	
1967	562620	562620	0	2.25	2.25	
1968	620693	557589	63105	2.73	2.40	5.68
1969	802723	657287	145435	3.01	2.47	5.46
1970	883462	648928	234534	3.28	2.45	5.58
1971	990759	643920	346839	3.36	2.36	5.21
1972	884355	562472	321883	2.99	2.09	4.57
1973	985023	544737	440286	3.05	1.76	4.63
1974	1050415	461835	588580	3.22	2.01	4.17
1975	1162246	502444	659801	2.94	1.85	3.76
1976	1148199	505870	642329	3.03	1.96	3.87
1977	854996	313344	541651	2.94	1.71	3.65
1978	1093895	451872	642024	3.12	2.15	3.80
1979	1071337	404501	666836	2.74	1.57	3.45
1980	1140702	417027	723675	3.39	1.99	4.19
1981	1160287	413605	746682	3.40	2.32	4.00
1982	1302434	404889	897546	3.63	2.36	4.20
1983	1433295	353005	1080290	3.65	2.15	4.14
1984	1401193	335187	1066006	3.58	2.32	3.98
1985	1574799	344403	1230395	3.72	2.44	4.07
1986	1533532	320348	1213284	3.59	2.12	3.98
1987	1673038	332332	1340707	3.59	2.12	3.98
1988	1942638	303775	1638863	3.65	2.16	3.93
1989	2372856	207181	2065673	3.60	1.99	3.84

Table D-4. Summary of activities of Variety Improvement Task Force (1986-90)

Activities	Irrigated	Direct Seeded Aus	T Aus	Deep Water	Rainfed Lowland	Total
Crosses Made	162	153	159	112	425	1011
F_1 Confirmed	179	92	128	88	473	960
F_2 Population						
# populations grown	265	104	128	259	732	1488
# plants selected	5699	953	2924	230	18472	28278
Pedigree Rows (F_3-F_6)						
# rows grown	17364	2196	10548	23721	42926	96755
# plants selected	14428	1220	6186	6669	3833	59336
# rows bulked	431	135	168	546	2290	3570
Screening against Biotic and Abiotic Stresses*						
# entries tested	2432	437	3276	969	6154	13268
# entries selected	492	150	373	122	827	1964
Observational Trial (Non-replicated)						
# entries tested	826	324	404	1867	2586	6007
# entries selected	169	96	113	462	862	1702
Replicated Trial (Regional)						
# entries tested	511	169	189	436	1405	2710
# entries selected	198	47	65	90	517	917
Adaptive Research (Farmer, NGO, Other Research Institute)						
# entries tested	38	12	31	36	47	164
# locations	57	13	39	11	67	187
Physico-chemical Test						
(# entries)	207	-	52	-	362	621
Time of planting (entries)	62	-	20	-	68	150
International Trials						
INGER (International Network for Genetic Evaluation of Rice)						
nurseries						80
# entries tested						6611
# entries selected						859
SAARC Trial						
nursery						1
# entries tested						16
# entries selected						5
Genetic Resources						
# var. collected	169	168	-	-	399	736
# var. characterized	786	1325	-	-	3707	5818
# var. processed (req. for seed)	4575	2147	-	-	3754	10476
Quantity of Breeder's Seed Produced						22.3 tonnes

*Biotic Stresses: Rice Tungro Virus (RTV), Bacterial Blight (BB), Sheath Blight (ShB), Stem rot (SR), Brown Planthopper (BPH), White Backed Planthopper (WBPH), and Green Leafhopper (GLH).

Abiotic Stresses: Submergence, Drought, Cold, Photoperiod sensitivity, Viability

ANNEX E
BRRI TRAINING PROGRAMS IN TECHNOLOGY TRANSFER

A. Regular Courses

Under a Memorandum of Understanding, BRRI provides rice production training (RPT) to DAE professionals. Training costs are borne by BRRI. The program is of three months' duration with 25-30 officers trained in each batch. Until 1990 program duration was four months.

The program is designed to enable participants to:

- Acquire knowledge and develop skills in rice production
- Identify and solve field problems of rice production
- Develop and execute efficient extension programs
- Conduct scientifically designed adaptive research adjusted to local conditions
- Coordinate BRRI field activities with farmers and their organizations and communities

Lectures cover areas including plant physiology, agronomy, soil science, rice technology, entomology, plant pathology, genetics and plant breeding, rice-based farming systems, postharvest technology of rice, farm machinery and equipment, agricultural economics, field experimentation and statistics, and adaptive research and training. Introductory lectures are provided on general socioeconomic and demographic conditions in Bangladesh.

A benchmark evaluation of participant knowledge of rice production is conducted before the start of the program. Evaluations are also conducted at the middle of the program, and theoretical and practical knowledge is determined at the end of the program for the purpose of grading each student. Although RPT is primarily designed for DAE staff, a small number of participants from other organizations such as BARI, BRRI, and NGOs also participate.

Between July 1985 and June 1990 BRRI conducted 9 RPT courses and trained 257 officials. Since inception in 1974, BRRI has trained about 700 DAE officials in RPT. DAE has 3,000 staff who require training in RPT; at the present rate, BRRI will require more than 60 years to train them. To increase training exposure, BRRI reduced the course duration to three months in 1990. A further restriction of the course duration to two months is under study so that BRRI can organize 4-5 courses annually. A typical 35-participant three-month RPT course costs 385,200 taka. Reducing training costs is also a consideration in reducing RPT duration.

B. Occasional Courses

In addition to the regular RPT courses, BRRI also conducts other training courses on various aspects of rice production for participants of interested organizations. Courses are organized as and when requested by the organization and are designed to meet their specific needs. Duration ranges from one day to two months, with costs paid by the participating organizations. From July 1985 to June 1990, 118 such courses were organized. Attendees included 3,364 participants from:

- Bangladesh Agricultural Research Institute
- Bangladesh Rice Research Institute
- Bangladesh Institute for Nuclear Agriculture
- Bangladesh Agricultural University
- Bangladesh Forestry Research Institute
- Bangladesh Water Development Board
- Bangladesh Livestock Research Institute
- Bangladesh Rural Advancement Committee
- Bangladesh Jute Research Institute
- Bangladesh Tea Research Institute
- Institute of Postgraduate Studies in Agriculture
- Sugarcane Research and Training Institute
- Directorate of Agricultural Extension
- Cooperative for American Relief Everywhere
- Mennonite Central Committee

Training topics covered diverse areas such as weather equipment, light trap, biological nitrogen fixation, soil fertility, irrigation and water management, ground water innertigation, and use of azola as biofertilizer. Between 1974 and 1990, BRRI trained 6,532 participants from 26 organizations other than DAE in specialized irregular courses on rice production.

C. Expanding Training for NGO Participants

BRRI has excellent subject matter specialists but has only two classrooms adequate to handle the regular RPT courses for DAE. BRRI receives a large number of requests for training from various organizations, including NGOs, but is unable to accept many because of limited facilities. BRRI has developed plans to move the training department to a separate building adjacent to the main building and employ more physical and manpower facilities to handle the increased volume of training. Lack of funds limits implementation.

D. Participation of BRRI Scientists in Other Teaching Programs

Beginning in August 1990, six BRRI chief scientific officers from agricultural extension, statistics, agronomy, plant pathology, soil science, and entomology were engaged to provide three lectures a week for one trimester a year to the graduate students of IPSA as

a regular collaboration between BRRI and IPSA. They guide the research work of M.S. and Ph.D. students using BRRI field and laboratory facilities.

In addition to routine training organized by BRRI, international sponsors request BRRI to organize programs for trainees from Bangladesh, Burma, Bhutan, India, Nepal, Pakistan, Indonesia, Thailand, Vietnam, and Sri Lanka. One such training course was organized by FAO/UNDP in 1981, one by IDRC in 1986, and one by IRRI in 1989.

ANNEX F
NGOs WITH AGRICULTURAL PROGRAMS

	PROGRAM	WORKING NGO
1.	CROP PRODUCTION - Field Crop (FC) - Rice (R) - Maize (M) - Soybean (S) - Sugarcane (SC)	HEED-BD (F.C.)/BNELC (S)/SAVE THE CHILDREN (FC)/WORLD VISION (FC)/ (SCI)/RDRS (SC)/GUP (S.GN.SC)/ MCC (S.GN)/CARE-INT. (FC)/BRAC/ COMILLA PROSHIKA (FC), CCDB/ CARITAS/B.D.S./MCC (FC)
2.	VEGETABLE CULTIVATION	HEED-BD/BNELC/SAVE THE CHILDREN,USA. WORLD VISION/SCI/RDRS/BRAC/ GUP/CARE-INT./PROSHIKA-MUN/ WIF/HBI/FIVDB/COMILLA PROSHIKA.
3.	POULTRY AND LIVESTOCK - Rearing (R) - Artificial Insemination	HEED-BD/BNLEC/UDDIPAN (R)/SAVE THE CHILDREN (R&AI)/SOPIRET/WORLD VISION BD/RDRS/BRAC (R&AI)/DEVELOPMENT FOR THE POOR/GUP/BAM INT./TARD/NEJERA KORI/PROSHIKA-MUN/FIFDB/CMES/ COMILLA PROSHIKA.
4.	PISCICULTURE - Viable (V) - Not Viable (NV)	ACTION AID/HEED-BD (NV)/BNELC (V)/ SAVE THE CHILDREN, USA/WORLD VISION (NV)/SCI (V)/RDRS (V)/GUP (V)/SHAPLA NEER/CARITAS-BD/MCC (V)/PROSHIKA-MUK (V)/SAPTAGRAM (V)/SWEDISH FREE MISSION (V)/TARD/FIVDB/NEJERA KORI/CENTRE FOR MASS EDUCATION IN SCIENCE (CMES).

5.	SERICULTURE - Plantation (P) - Rearing (R) - Garments (G) - Plantation & Rearing (P&R) - All (A)	SAVE THE CHILDREN, USA (P)/BRAC (A)/ TDH (ERRIALS)- (P&R) PROSHIKA MUK(A)/CARITAS (P)/SAPTAGRAM NARI SHAW NIRVAR PARISHAD/(P&R)/RDRS (A)/MIDAS (G)/SEDS (P&R)/PSK & FPS (P&R)/BASTE SHIKHA (P 7), JAGORONI CHAKRA (P&R)/SFCAL (A)/SHAWUNNAYAN (P)/CCDB ( )/SARA ( )/SERI WELFARE FEDERATION ( ) /UNNAYAN SANGHA ( ) /BIGGAN & GONO SHIKKHA KENDRA (P).
6.	SOCIAL FORESTRY	WORLD VISION-BD/TDH-S/GUP/CARTAS/BAM-INT./PROSHIKA 9MUK)/RDRS/MCC/ EDM/COMILLA PROSHIKA/SCI/BRAC/INST. FOR 21ST CENTURY STUDIES/ASA/SAVE THE CHILDREN (USA)/CMES/BCAS/IUCN/CARE.
7.	IRRIGATION	INTERNATIONAL DEV. ENTERPRISE/SCI/ RDRS/GUP/PROSHIKA (MUK)/FIVDB/CARE-INT./BRAC.

ANNEX G
A CASE STUDY OF BRRI FSR RESEARCH
KAMALGANJ AND SITAKUNDA

A. Introduction

FSR in BRRI began in 1976. The objectives are to conduct experimentation in different agroecological regions of the country on farming system activities, taking the whole farm with all its various enterprises as one interlinked production activity. This is followed by assessments of the impact of the activities on farm productivity and farm family welfare. Multilocation tests of the cropping system technologies, including several other trials, are done in cooperation with DAE and farmers in 39 locations in four different agroecological environments. In 1989 FSR entered into phase II. During this phase, research continued in the old FSR sites (Kamalganj in Moulvibazar district and Sitakunda in Chittagong district) while two new sites, Sreepur in Gazipur district and Mirzapur in Tangail district, were included in 1990.

B. Achievement

Impact studies document major achievements by FSR. An important paper in this respect is the *Review Report on Impact of Modern Rice Technology in Two Rainfed Low Land Sites in Bangladesh* by M.R. Siddiqui, R. Islam, A.H. Khan, N.P. Magor, and N.U. Ahmed. The paper was chosen as one of three best of 111 papers presented at the Symposium on Subsistence Farming Systems for the 21st century held in Bangkok, November 19-22, 1990.

C. A Critique of FSR Research

The study was conducted on 65 farm households in Sitakunda FSR site in Chittagong district. The farmers were of marginal to medium size, ranging from .02 to 3 ha. Aus rice followed by aman rice is the major cropping pattern in the area. The study revealed that all farmers adopted improved rice technology: 46 percent of the farmers were low adopters, 35 percent were medium adopters, and 19 percent were high adopters.

Farm size was not a constraint in adoption of modern rice technology. On the contrary, small farmers were better adopters: 40 percent of the marginal and small farmers were low adopters and 22 percent were high adopters, compared to 60 percent of the medium farmers who were low adopters and 10 percent high adopters. High adopters obtained higher yield for both aus and aman rice. They obtained 3,354 kg of combined aus and aman rice per hectare, 67 percent higher than the yield of low adopters and 12 percent higher than the yield of medium adopters.

The higher yield of high adopters primarily resulted from higher applications of labor and fertilizer. The high adopters used larger amounts of labor and fertilizer per hectare both for aus and aman rice. They used 1,946 man hours of labor per hectare of combined aus and aman rice which was more than double the application rate of low adopters and 39 percent more than the application rate of medium adopters. With respect to fertilizer use, high adopters used 113 kg of nitrogen per hectare for combined aus and aman rice, which was more than three times the application rate of low adopters and 55 percent more than the application rate of medium adopters. The differences in the use of other fertilizers are not very marked.

High adopters obtained higher net returns per hectare and higher returns to family inputs for both aus and aman rice. Their net return was 7,233 taka per hectare for combined aus and aman rice, which was more than double the net return of low adopters and 28 percent more than the net return of medium adopters. Their return to family labor was 2.49 taka per taka of labor wage paid, which was 28 percent more than the return to family labor for low adopters and 21 percent more than the return to family labor for medium adopters.

High adopters also had more overall farm income, more nonfarm income, invested more in agriculture, and had higher consumption expenditures and higher positive balances at the end of the year. They had overall annual farm incomes of 66,206 taka per farm which was 12 percent more than the income of low and medium adopters. They had annual nonfarm incomes of 179,582 taka, which was about twice the income of low adopters and about three time the income of medium adopters. They had annual farm investments of 33,025 taka, which was 27 percent more than the investments of low adopters and 76 percent more than the investments of medium adopters. They had annual family expenditures of 124,392 taka, which was 58 percent more than expenditure of low adopters and 90 percent more than the expenditures of medium adopters. They had annual net balance of 88,368 taka, which was 54 percent more than the balance of low adopters and about two and a half times the balance of medium adopters.

The results show very significant contributions of FSR activities to increasing production, promoting equity, and reducing poverty in rural areas. Although these effects of FSR cannot be contested, several criticisms may be levelled against the analytical methods used and presentation of findings in the report:

1. FSR collected very detailed and comprehensive data on farm and farm family activities for two years on a weekly basis from 154 selected families. Presenting only limited income and expenditure data for a sample of 65 families is an inadequate treatment of the compiled database.

2. Farm activities that have been analysed in some detail are aus and aman rice. Analysis of the rabi crop (the third crop in the annual crop sequence) has not been done. Data on nonrice farm activities, nonfarm activities, farm expenditure, and family expenditure have been treated in high aggregates. The analysis suggests that FSR is just another rice cropping system research activity rather than a total farm research activity.

3. Financial return analysis of crop returns to family labor, hired labor, animal power, and material inputs have been shown in taka for per taka investment on the inputs. The analysis is misleading at least on two grounds. First, hired labor, most of the material inputs, and part of the animal inputs are purchased resources to farmers. Return to these inputs in the process of farming do not convey much meaning. Instead, returns to family labor, returns to family inputs (labor and animal), and returns over cash costs could have been provided as is done in conventional farm business analysis reports. These factors summarize the important information needed for improved farm business planning.

   Secondly, returns to family labor is shown in taka for the family wage bill. This is misleading. Usually returns to family labor are estimated on per labor day basis to show whether family earnings from farming are higher or lower than the prevailing opportunity cost of labor. Using the available data we have done some recalculation of returns to family labor which show a return of about 100 taka per labor day for high adopters, 80 taka per labor day for medium adopters, and 78 taka per labor day for low adopters (assumes an eight hour work day) compared with the opportunity cost of family labor valued at 40 taka per day in the study.

4. The presentation of income expenditure data is also misleading. Firstly, table G-1 indicates that the data are shown on a per hectare basis. It is not clear how nonfarm income, farm expenditure, and family expenditure can be shown on a per hectare basis. A better presentation of the data would be on a per farm basis grouped by farm size.

   Secondly, high income, high expenditure, and high annual net balance figures across adoption levels seem puzzling and unbelievable although some explanation (such that Sitakunda lies in an urban periphery) has been provided. Nonfarm labor income ranges from 11,700 taka to 36,000 taka, total nonfarm income ranges from 63,000 taka to 179,000 taka, total farm expenditure ranges from 19,000 taka to 33,000 taka, and total family expenditure ranges from 65,500 taka to 124,000 taka across adoption levels annually. These seem too high, and even higher if expressed on a per hectare basis.

   Total farm incomes which range from 59,000 taka to 66,000 taka annually across adoption levels also seem high. One wonders how the averages have been worked out. Average farm sizes of low, medium, and high adopters is small: .98 ha, .79 ha, and .59 ha respectively. If the averages have been calculated by calculating averages per hectare first for each farm individually and then calculating the final averages for all farms (a weighted average method is followed), then the final averages are likely to show higher estimates than the estimates provided by a simple average method.

Subsistence consumption—consumption by a farm family of its own farm products—has been shown as farm income, but has not been shown as farm expenditure, which might have inflated the net annual balance by 17,800 taka to 20,600 taka across farms. The figures must in any event be checked for two possible sources of error: (1) personal bias in data collection; and (2) estimation bias due to method of estimation followed.

5. No comparison is made between adopters and nonadopters. An important approach to present the data would be to show comparisons among nonadaptors, low adopters, and high adopters for a few model (typical) farm sizes and family compositions using farm model approach and budgeting techniques. Comparisons may be shown on land use intensity, cropping pattern, noncrop enterprises, homestead utilization, input use, output, farm income, return to family labor, family consumption, farm and home inventory, participation in market economy, social behavior, and education and nutrition to show paths to development through technology adoption. From this one can expand to the whole farm economy, compare them with costs, and justify expenditure on technology adoption, research, and related activities.

D. Conclusions

FSR activities have merit in promoting farmer welfare, particularly of the marginal and small farmer of the country. But BRRI scientists, while doing a good job of data collection, are not following through with appropriate farm economic and financial analysis. Secondly, FSR involves a research methodology different from that used in other research activities at BRRI. What it involves basically is: (1) collection of existing cropping pattern and homestead utilization data from different agroecological zones through field interviews; (2) identification of more profitable cropping patterns based on agroecological research findings; (3) identification of compatible homestead activities such as home gardening, poultry, livestock, and fish farming based on farmer resource availability and research results; (4) comparing the financial returns of the alternative cropping patterns and activities with the existing cropping patterns and activities based on regional costs and returns studies; and finally (5) suggesting the best cropping patterns and activities for different agroecological zones.

The above research methodology fits the specialization of agricultural extension economists trained in farm management research methods. While the ideal would be to shift FSR leadership to DAE, the lack of trained professional staff in that directorate precludes this as a viable short-term option. Instead, BRRI agricultural economists with a farm management/production economics specialization should take the lead in conducting the economic analysis associated with FSR research.

Table G-1 Income and expenditure /ha according to the extent of adoption, Sitakund Impact Study Site, 1989.

Items	Extent of adoption		
	Low	Medium	High
Farm Income			
Consume	18902	16785	20625
Faddy-sale	903***	3263	4564
Other crops	21433	9497	9350
Vegetables	7626**	15634	12257
Fruit	1475	1675	1049
Livestock	8469	11648	17927
Fuel	104*	543	434
Non-Farm Income			
Service	23244	19843	37281
Business	24610	9875	31166*
Overseas	5849	3025	44135**
Labour	11680*	19456	35919
Loans	6307	5869	13936
Share	1571	201	1424
Fixed asset sale	16908	4331	13854
Gifts	716	300	1867
Expense Farm			
Inputs	4378	4529	5929
Labour	4651	6920	8514
Livestock	2048	4206	4724
Land	15028	3072	13858**
Expense Home			
Rice	24902	15271	26199
Cereal	1959	1328	3129**
Vegetables	6886	6266	11199**
Meat	12507	10627	19245*
Food other	9011	9327	19393
Cloth	6213	6110	9706
Education	1835	816	1610
Medicine	1354	943	5078***
Energy	359	395	488
Other nonfood	10354	11372	16345
Asset	882	1706	451
Business inputs	153	11	172
Loan	2194	1333	11379**
Balance	57212	37715	88368

1. Comparison between low and medium adopters;
2. Comparison between medium and high adopters;

*** Significant at 1 percent level, ** significant at 5 percent level and * significant at 10 percent level.

ANNEX H
REPORTS AND DOCUMENTS REVIEWED

Abdullah, Tahrunnesa	*Women in Rice Farming Systems in Bangladesh and How Technology Programs Can Reach Them*, Dhaka, 1989
ADAB	*Directory of NGOs in Bangladesh*, 1990
ARP(II)	*Human Resources Study of the National Agricultural Research Project System: A Narrative Draft Report*, Dhaka, 1990.
BARC	*Agricultural Research in the Fourth Five-Year Plan 1990-95*, July, 1990.
BARC	*Agricultural Research in Bangladesh Contributing to National Development*, Dhaka,1983.
BBS	*Statistical Year Book*, Dhaka, 1989.
BRRI	*About BRRI, a Publication of The Bangladesh Rice Research Institute*, Dhaka, 1989.
BRRI	*Annual Report for 1988*, Dhaka 1989.
BRRI	*A Scheme for Continuation and Expansion of Rice Research and Training (1985-90)*, Dhaka, August, 1988.
BRRI	*BRRI Annual Internal Reviews, 1988 to 1991*, Dhaka.
BRRI	*Multilocation Testing: BRRI Key Site Research (RFS)*, (Draft Report), Dhaka, 1990.
BRRI	*Quarterly Reports*, BRRI/IRRI Project, January 1988 to September 1990, Dhaka.
BRRI	*BRRI Annual Internal Review for 1989, 15-19 March, 1990, VII - Rice Farming System*, Dhaka, 1990.
BRRI	*BRRI Annual Internal Review for 1990, 2-7 March, 1991, VII - Rice Farming System*, Dhaka, 1991.
BRRI-IRRI	*BRRI-IRRI Rice Research and Training Phase III. BRRI-IRRI Contract 1985 and 1988*, 1985, Dhaka

Chowdhury, S.D. J.R. Cowan, W. Foote, and W. Freeman	*Review of the Research and Administrative Management Systems for BRRI*, 1985, Dhaka
Dey, Modan Mohan and Robert E. Evenson	*The Economic Impact of Rice Research in Bangladesh*, USAID, Dhaka, 1991.
GOB	President's Order No. 32 of 1973 (The BARC Order, 1973) Amendment Date May 24, 1988.
Hossain, Mahabub	*Nature and Impact of the Green Revolution in Bangladesh*, Research Report 67, International Food Policy Research Institute/Bangladesh Institute of Development Studies, 1988.
ISNAR	*Agricultural Research in Bangladesh: Major Areas of Concern*, Dhaka, June, 1990.
Karim, Z. and M.I. Ali	*Fertilizer Recommendation Guide*, BARC, Dhaka, 1989.
Khush, Gurdev S.	*Redesigning the Rice Plant*, Shell Agriculture 23-27, 1991.
Mahtab, F.U., Z. Karim, and Fasih Uddin	*Population and Land Use Towards Sustainable Food Production System in Bangladesh*, Conference on Population, Natural Resources, and Development, Swedish Academy of Sciences and Swedish Council for Planning and Coordination of Research, Dhaka, September-October, 1991.
Mannan, M.A.	*Deepwater Rice in Perspective: A Keynote Address,* International Workshop, Bangkok, 26-30 October, 1987.
Miah, N.M.	*Breeding Research on Rice in Bangladesh*, National Symposium on Plant Breeding, Dhaka, 1989
Miah, S.A.	*Rice and Food Self Sufficiency in Bangladesh*, A paper presented in BAAS Conference, January, 1987.
Ministry of Agriculture	*Crop Agriculture Development Programme For the Fourth Five-Year Plan (1990-1995)*, Dhaka, January, 1990.
Ministry of Agriculture	*The Seed Policy of Bangladesh*, 1990, Dhaka.

Ministry of Agriculture	*A Review of the ISNAR Report*, Dhaka, April 1991
Orr, Alastair Islam, M.M. Haq, A.S.M.N., and N. Magor,	*Economic Constraints on Turnaround Time in Bangladesh, A Pilot Study*, Dhaka, 1988.
Sefilios-Rothschild, Constantina and Sireen Mahmud	*Women's Role in Agriculture: Present Trends and Potential for Growth*, Bangladesh Agriculture Sector Review.. UNDP and UNIFEM, Dhaka, March, 1989.
Siddiqui, M.R., R. Islam, A.H. Khan, N.P. Magor, N.U. Ahmed	*Review Report on Impact of Modern Rice Technology in Two Rainfed Low Land Sites in Bangladesh*, Dhaka, November 1990.
UNDP/FAO	*Land Resource Appraisal of Bangladesh—Agricultural Development*
USAID	*USAID Project Paper, Amendment #2. Bangladesh Agricultural Research Project Phase II*, Dhaka, November, 1986.
USAID	*Final Evaluation Agricultural Research Project Phase II - Supplement*, Dhaka, July, 1991.
Zillinsky, F.J. and L.H. Shebeski	*A Special Review of BRRI Proposal for Phase III Funding*, BRRI, Dhaka, 1987.

ANNEX I
INDIVIDUALS CONTACTED

AST

Dalgliesh, Ron, Team Leader
Dr. Hassanullah, M., Consultant

BARC

Dr. Chowdhury, M.S., Executive Vice Chairman
Dr. Elias M., Member Director (Agricultural Economics)
Dr. Karim, Z., Member Director (Soils & Irrigation)

BARI

Ali, Hazrat M., Senior Scientific Officer
Amin Ruhul, Senior Scientific Officer
Dr. Haque M. Mahiul, Principal Scientific Officer
Dr. Islam Ashraful, In-charge, OFRD
Dr. Maniruzzaman, A.F.M., Director (Research)
Dr. Quddus, M. Abdul, Senior Scientific Officer
Khaleque A., Director (Oilseeds) Retd.
Kabir, M.A., Principal Scientific Officer

BRRI

Dr. Ahmed Nizamuddin, PSO & Head of RFS
Dr. Islam A.J.M. Azizul, Director General
Dr. Jamil, Farhat, CSO & Head of Training
Dr. Quddus, M. A., Principal Scientific Officer
Dr. Miah, S.A., Coord. for Advance Studies & Research
Dr. Miah, N.M., CSO & Head of Plant Breeding Division
Dr. Miah, M.N. Islam, Senior Scientific Officer
Jabbar A., PSO & Head of Agricultural Economics
Shamsuddin, A.K.M., Principal Scientific Officer

BRRI R.S. Rajshahi

Ali, Md. Liaqat, Incharge, SSO, (Breeder)
Ahmed, Helaluddin, Scientific Officer (Breeder)

Rahman, M. Khalilur, Principal Scientific Officer
Siddique, M.M.R., Senior Scientific Officer (RFS)

BRRI R.S. Comilla

Dr. Das, Tulsi, Chief Scientific Officer, In-Charge
Dr. Nur-e-Elahi, M., Principal Scientific Officer
Dr. Rabbi, Fazley, Senior Scientific Officer

CIDA (CDP)

Dr. Quddus, M. A., Principal Scientific Officer
Field, David, Senior Agriculture Advisor
MacGregor, Malcolm, Resident Project Manager
Pathan, Giasuddin
Siddiqullah, Planning & Evaluation Adviser

CIDA (Potash)

Dr. Habibullah, A.K.M

CHC

Rayfield, Steve, First Secretary (Development)

IRRI

Dr. McIntosh, J., Technical Advisor
Magor, N., Technical Advisor

USAID

Brown, Donald, Office Director, Food & Agriculture
Ms Jan Rockecliff-king
Dr. Morton, Ray, Project Officer
Rahman, Latifur, Agricultural Officer
Rahman, Habibur, Project Officer

OTHER AGENCIES

ARP II (s)	:	Dr. Madamba, Joseph, Team Leader
BADC	:	Dr. Jalil, Mirza, Chairman
DAE	:	Islam, M. Shahidul, Director General
MOA	:	Hossain, M. Akmal, Joint Secretary