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INTERNATIONAL RICE RICE RESEARCH INSTITUTE

COLLABORATIVE PROJECTS WITH GENEROUS SUPPORT FROM U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT (USAID)

October 1986

The International Rice Research Institute

USAID SUPPORTED PROJECTS AND PROPOSALS FOR FURTHER COLLABORATION IN RICE RESEARCH AND TRAINING

1. Extension of Small Scale Agricultural Equipment

a) Indian Council of Agricultural Research (ICAR) (Central Institute of Agricultural Engineering (CIAE)-IRRI Project on Small Farm Machinery

The CIAE-IRRI Industrial Project in Coimbatore was terminated on September 30, 1986. The project was successful in commercializing the IRRI thresher and the one meter reaper. The industrial extension project at Coimbatore now forms an integral part of the CIAE Industrial Extension Division. Dr. T.P. Ojha, Director of the CIAE, has agreed to provide additional staff and budgetary support to the industrial extension activities at Coimbatore.

b) Ministry of Agriculture and Food (MAF)-IRRI Program for Small Farm Equipment

Support for the MAF-IRRI Industrial Extension Project from USAID-Washington terminated on September 3, 1986. USAID-Manila has provided a grant of $228,000 for an extension of the activities for the period October 1, 1986-July 31, 1987.

This project was recently reviewed by a USAID-Government of the Philippines (GOP)-Private Sector team. The review team expressed satisfaction with the excellent progress made by the project and has recommended that MAF should provide necessary funds to sustain the program beyond July 31, 1987. The project's principal thrust during the next ten months is to strengthen the institutional structure of the MAF-IRRI Program. A copy of the program description of this project is appended as Annexure 1a and status report as Annexure 1b.

c. Participants to Agricultural Engineering Training Course

In 1985-1986, 44 agricultural engineers and technicians from 13 countries were trained in the Agricultural Engineering Course held at IRRI on May 27-June 4, 1985; November 18 - December 6, 1985; and May 26-June 13, 1986.

2. <u>USAID-IRRI-Malagasy Rice Research Project</u>

With the financial support of USAID, IRRI is providing assistance to the Government of Malagasy to develop a strong and effective national rice research program. The first phase of the Project, which ended August, 1986, was financed by a $1.2 million grant from USAID. The agency is providing a grant of $2.28 million over a 2-year period to continue strengthening of research capabilities of the National Center of Applied Research in Rural

Development (FOFIFA). The grant finances short- and long-term technical assistance, degree and non-degree training, conference participation, and commodity purchase. For the second phase, USAID has also approved $3.708 million in local currency (PL480 funds) for building construction, personnel, operating expenses, and equipment and supplies. In 1985-1986, 17 scientists of FOFIFA participated in various training programs as follows:

Nondegree program	1
Short-term courses:	
Genetic Evaluation & Utilization (GEU)	4
International Network on Soil Fertility and Fertilizer Evaluation in Rice (INSFFER)	3
Cropping Systems Training Program (CSTP)	2
Integrated Pest Management (IPM)	3
Basic Rice Production Course (BPRC)	2
Farming Systems Socioeconomic Research	2

A copy of the program description and the report on review of progress are appended as Annexures 2a and 2b.

3. Cooperation between the Egyptian Ministry of Agriculture (MOA) and IRRI

The collaborative research and training program between the Ministry of Agriculture, Arab Republic of Egypt and the

International Rice Research Institute was initiated in 1980 under a subcontract from the University of California. Under this Program, IRRI has provided assistance to the Ministry of Agriculture in rice breeding, farm mechanization, extension and training of scientists. This Program was terminated in November, 1985. However, at the request of the Egyptian Ministry of Agriculture, IRRI has agreed to make available the services of Dr. E.A. Siddiq, Rice Breeder, until February, 1987, for strengthening ongoing work in the field of breeding for resistance to diseases particularly blast. Under this program, Dr. Thouraya El Bigawii and Dr. Serag Kamel came to IRRI to undergo training on blast for 3 months and 2 weeks, respectively. A report on the status of the Program is appended as Annexure 3.

4. Monoclonal Antibody Research Project

The project involves the production of monoclonal antibodies to rice viruses in collaboration with Dr. Hei-Ti Hsu of United States Department of Agriculture, Beltsville, Maryland. Todate, a monoclonal antibody to rice grassy stunt virus has been produced and the production of monoclonal antibodies to rice tungro-associated viruses is being undertaken. A progress report on the program is appended as Annexure 4.

5. USAID Bottlenecks Project

This project on "Removing soil structural constraints to the production of maize and legumes following rice" became operational on September 15, 1986. However, prior to that date, Dr. T. Woodhead of IRRI visited, on 3 occasions, Profs. W.E. Larson and S.C. Gupta at the University of Minnesota for project planning purposes and also carried Philippine soil samples. As a direct result of these visits, an agreed work plan for the period July 1986 - June 1987 was finalized, as per Annexure 5a. Also appended is a progress report, Annexure 5b.

6. Hydrolysis of Rice Husk to Ethanol

This is a joint prepoposal by IRRI, in collaboration with the Institute of Biotechnology, University of the Philippines at Los Banos, for the study of acid hydrolysis conversion of rice hulls to ethanol or other products. The project involves the Tennessee Valley Authority (TVA). A copy of the preproposal submitted to Dr. Joseph Riley at TVA is appended as Annexure 6.

7. Gasification of Rice Husk

A project on Gasification of Rice Husk initially funded by the Office of Energy/AID Washington has provided support for 2 PhD students at the University of California, Davis. Their graduate scholarship is currently funded through USAID Manila with local funds provided until December 1986. The students have performed well in their graduate program and their thesis project on gasification of rice husk would greatly contribute to the energy program of the developing countries. For this reason, a one year extension of their funding is being sought to insure completion of their degree program. An interim report of the program is appended as Annexure 7.

8. USAID-BRRI-IRRI Rice Research and Training Project Phase II

Through the donor consortium, the Government of the Peoples Republic of Bangladesh intends to strengthen the country's research capacity and develop improved rice varieties and production practices. Acting through the Bangladesh Rice Research Institute, the Government entered into an Agreement pertaining to "Agricultural Research Project - Phase II" designating IRRI as the Contractor for the technical and related assistance required for implementation of the Project. USAID committed and obligated $3 million to cover costs of services from June 6, 1981 to June 30, 1987. A copy of Amendment No. 2 to this contract is appended as Annexure 8.

PROGRAM DESCRIPTION

MAF-IRRI PROGRAM FOR SMALL FARM EQUIPMENT

Grant No. AID 492-0366-G-1C-6100-00

PROGRAM DESCRIPTION

I. BACKGROUND

In 1981 the Ministry of Agriculture and Food (MAF) and the International Rice Research Institute (IRRI) initiated a collaborative project entitled "MAF-IRRI" Industrial Extension Program for Small Farm Equipment". The project was financed by a grant to IRRI from USAID/Washington for the purpose of assisting national institutions in four developing countries to strengthen their capabilities for the development and extension of locally-made agricultural equipment suitable for small farms.

The MAF-IRRI Program was evaluated in 1984 by representatives of USAID, MAF, the manufacturing sector, and the Bureau of Small and Medium Industries (Ministry of Trade and Industry). The principal recommendation of the evaluation team was that the Program should be continued at least until October 1987 to "enable BPI to gain needed additional institutional capability and to maintain its recently acquired momentum". The MAF has requested that USAID/Manila provide grant funds to support the continuation of the MAF-IRRI Program.

The purpose of the continuation of the MAF-IRRI Program is to establish MAF's capability for the development and extension of locally-manufactured agricultural equipment which will benefit small farmers, especially those in rainfed areas. At first, the MAF-IRRI Program promoted existing IRRI-designed equipment that generally are most appropriate for irrigated rice farms. However, during the last three years the Program has begun to direct its effort towards rainfed areas and upland crops. The Tapak-tapak pump, Sipa pump, sweet potato chipping machine, thresher/sheller, and seed and fertilizer applicator are concrete examples of this effort.

The specific objectives for the continuation of the Program are:

a. Develop and promote equipment suitable for small farmers lacking irrigation during part or all of the year. Examples: (1) low-cost pumps; (2) minimum tillage and planting devices to conserve residual moisture and/or reduce the time and risk of crop establishment; (3) manually-operated rice seedling transplanter to speed up the establishment of a second rice crop in a rainfed cropping pattern; (4) manually-operated row seeder to replace direct seeding by broadcasting, - a practice which pushes farmers to use herbicides, whereas the row seeder enables them to use the manually-operated push weeder.

b. Develop and promote low-cost postharvest equipment (e.g., chipping machines, threshers, shellers, and dryers) that will reduce losses due to deterioration and will increase the prices received by farmers for their products. Proposed priorities: improved sundrying practices; the IRRI warehouse-type dryer; and the MAF-IRRI rotary dryer.

9'

c. Develop and promote equipment that will help farmers to increase the production of priority crops such as rice, yellow corn, sweet potato, and soybean. Examples: (1) seed and fertilizer applicator which economizes on fertilizer by proper placement; (2) animal-drawn weeder suitable for weeding corn earlier than the present farmers' practice of using the traditional plow (weeds are often the major problem of upland crops); (3) postharvest equipment (as described above).

d. Strengthen collaborative work with the ARO and RIAS system, as well as with agricultural colleges and universities. The Program has collaborated with: UPLB on corn shellers and rice transplanters; VISCA on chipping machines and seed and fertilizer applicators; CLSU on the tapak-tapak pump; University of Eastern Samar on training.

e. Strengthen manufacturers of agricultural equipment suitable for small farms. This involves continuation of training, technical assistance, and prototype testing.

The experience of the past five years indicates that the primary strength of the MAF-IRRI Program is that it combines the unique capabilities of the two institutions, MAF and IRRI, in an effective manner to achieve the desired objectives. The capabilities of MAF and IRRI are complementary, and both are essential to the Program's success. For example, through its direct contact with farmers in all regions of the country, MAF is capable of carrying out demonstrations and trials to determine which types of equipment are most suitable, - and then follow up with extension activities to promote these equipment and, when necessary, make adaptations to varying local conditions. On the other hand, IRRI is capable of R&D on equipment requiring advanced scientfic and technological knowledge and facilities, including inputs from economists, farming systems specialists, irrigation engineers, soil and plant scientists, and other disciplines available at IRRI.

II. SCOPE OF WORK

The Grantee shall provide training and assistance necessary for establishing MAF's institutional capability for the development and extension of agricultural equipment appropriate for small farms. The training and assistance will concentrate on developing MAF staff capabilities to perform the following functions on developing MAF staff capabilities to perform the following functions which are essential to the effective sustained operation of the Program:

1. Definition and selection of equipment priorities for the target beneficiaries, e.e., small farmers in rainfed areas;

2 Development of equipment (design plus adaptation to local conditions);

3. Testing and evaluation of equipment (laboratory and field station testing, followed by on-farm demonstrations and trials to determine farmer acceptance);

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4. Promotion of equipment to manufacturers (field demonstrations for farmers and manufacturers; dissemination of simplified technical information);

5. Technical assistance to manufacturers (training courses, periodic follow-up visits, loaning prototype equipment to facilitate fabrication of first unit, and feedback of manufacturing problems to Central Office);

6. Monitoring and evaluation (technical and economic evaluation of equipment being promoted; monitoring of performance/progress of staff; evaluation of extension activities, strategies, and procedures).

By the end of this Grant, all participating MAF staff members in the Central Office at BPI and in the 12 MAF regions (one engineer per region) will have attended the three-week agricultural engineering training course at IRRI, followed by non-formal on-the-job training for 3 months with respect to specific equipment and the six activities listed above.

The Grant provides funds for one Liaison Engineer who, together with the BPI Engineering Chief, will be responsible for overall coordination of the training and technical assistance for the Project. This person shall have the following qualifications:

1. M.S. or Ph.D. in Agriculture or Mechanical Engineering;

2. Practical experience in developing countries with appropriate technology for small farmers, including R&D, manufacturing, and extension;

3. Ability to identify equipment priorities, including considerations of socio-economic factors as well as technical characteristics;

4. Capability for planning and coordinating formal and non-formal training;

5. Ability to identify and utilize the scientific, technical, and infrastructure/facilities of IRRI to respond to the needs of the Project;

6. Ability to provide coordination and leadership to the Project's support staff, including proper management of facilities and funds.

Funds are provided for a support staff consisting of:

1. Assistant Engineer who will assist in training, equipment development and testing, and monitoring and evaluation.

2. Secretary/Bookkeeper who will be responsible for correspondence, reports, transportation arrangements, appointments and meetings, communications with regional engineers and cooperating manufacturers, and bookkeeping.

3. Driver/Field Aide for the project vehicle, as well as to assist with demonstrations, tests, and equipment development.

4. Short-term Engineers and Laborers, as needed, for fabrication of equipment, testing, and specific equipment development tasks.

The Liaison Engineer shall submit quarterly progress reports which identify accomplishments and problems to be resolved. The project will be guided by an Advisory Committee which is chaired by the MAF Minister or his representative, and includes participants from BPI, IRRI, UPLB, Ministry of Trade and Industry, and the private industrial sector.

III. OUTPUT

At the end of this Grant, MAF should have the necessary trained staff and organization system for a sustained program on the development and extension of small farm equipment. The trained staff will include at least six members of the BPI Agricultural Engineering Division and 12 regional engineers. The BPI workshop will have the equipment and tools necessary for fabricating prototype equipment and for training purposes. Communication between MAF and IRRI will be established to ensure sustained collaboration, but without outside funds, after completion of this Grant.

A final report shall be submitted one month before the completion of this grant. This report will summarize accomplishments and describe how the effort will be sustained by MAF.

V. DETAILED WORK PLAN AND TIME SCHEDULE

Within 60 days of the signing of an agreement with IRRI, but not later October 1, 1986, IRRI will submit to MAF and USAID, for their concurrence, a detailed work plan and time schedule. This plan shall detail efforts during the period through July 31, 1987 to ensure that activities underway will continue, even after USAID funding has ended. Such plans should include at a minimum: (1) the staffing, funding and proposed program to be supported by MAF after July 1987, (2) the linkages with the private sector for manufacturing and marketing and how they will be supported, and efforts during the period of this agreement to put these systems in place, and (3) the proposed long term relationship between IRRI and MAF in this area based on the level of resources the MAF is likely to be able to make available.

VI. REPORTS

Four copies of all quarterly and final reports shall be submitted to:

Office of Rural and Agricultural Development
USAID/Manila
16th Floor, RMC Building
1680 Roxas Blvd. Manila 2801

and

National Economic and Development Authority
NEDA sa Pasig, Amber Avenue
Pasig, Metro Manila

OPTIONAL STANDARD PROVISIONS FOR NON-U.S., NONGOVERNMENTAL GRANTEES

INDEX OF OPTIONAL STANDARD PROVISIONS

ANNEXURE 1B

STATUS REPORT

MAF-IRRI PROGRAM FOR SMALL FARM EQUIPMENT

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EXPERIENCES OF THE MAF-IRRI COLLABORATIVE PROGRAM ON SMALL FARM EQUIPMENT IN THE PHILIPPINES

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ABSTRACT

The Philippine Ministry of Agriculture and Food (MAF) and the International Rice Research Institute (IRRI) have collaborated for five years to promote the development and extension of locally-made agricultural equipment appropriate for small farms in the Philippines. The Program is designed to utilize the particular capabilities of the four key participants: the farmer, the manufacturer, MAF, and IRRI. This paper describes how each of these four has contributed to the development of appropriate equipment, including a foot-operated pump, propeller pump, two-wheel tractors, seeders and planters, and threshers and shellers. A methodology has been established for equipment development, beginning with priorities defined by farmers and ending with detailed technical and socio-economic evaluations of equipment owners, users, landless workers, and manufacturers. Specific cases are presented.

I. INTRODUCTION

In developing countries, one of the main factors limiting the productivity of small farms is the lack of appropriate agricultural equipment. For example, pumps and minimum tillage planters are needed to increase cropping intensity in rainfed areas; weeder/cultivators to improve weed control; threshers, shellers, and dryers to reduce crop losses. However, a common problem is:

1. Imported equipment is often inappropriate because it is too expensive, large, heavy, or difficult to repair.
2. Locally-produced equipment is generally scarce and/or primitive because local manufacturers lack capital, personnel and technology for equipment development. Moreover, progressive manufacturers generally focus on the needs of larger farms, ignoring small farms.

In response to this problem, the MAF-IRRI Program was created in 1981 to help small-scale industries in the Philippines to design and manufacture appropriate small-farm equipment, thereby achieving:

- low costs of production and marketing
- modification of designs to meet local conditions and farmers' preferences
- utilization of indigenous materials and fabrication methods
- availability of spare parts and repair
- employment generation through labor-intensive manufacturing methods

The Program is a collaborative effort of the Philippine Ministry of Agriculture and Food (MAF) and the International Rice Research Institute (IRRI) with funds provided by the US Agency for International Development (USAID).

II. METHODOLOGY

As indicated in Figure 1, successful development of small-farm equipment requires close collaboration between the consumer (FARMER), private industry (MANUFACTURER), government (MAF), and modern science and technology (IRRI). Attainment of this partnership has been the major achievement of the MAF-IRRI Program, as illustrated in the case studies in Section III.

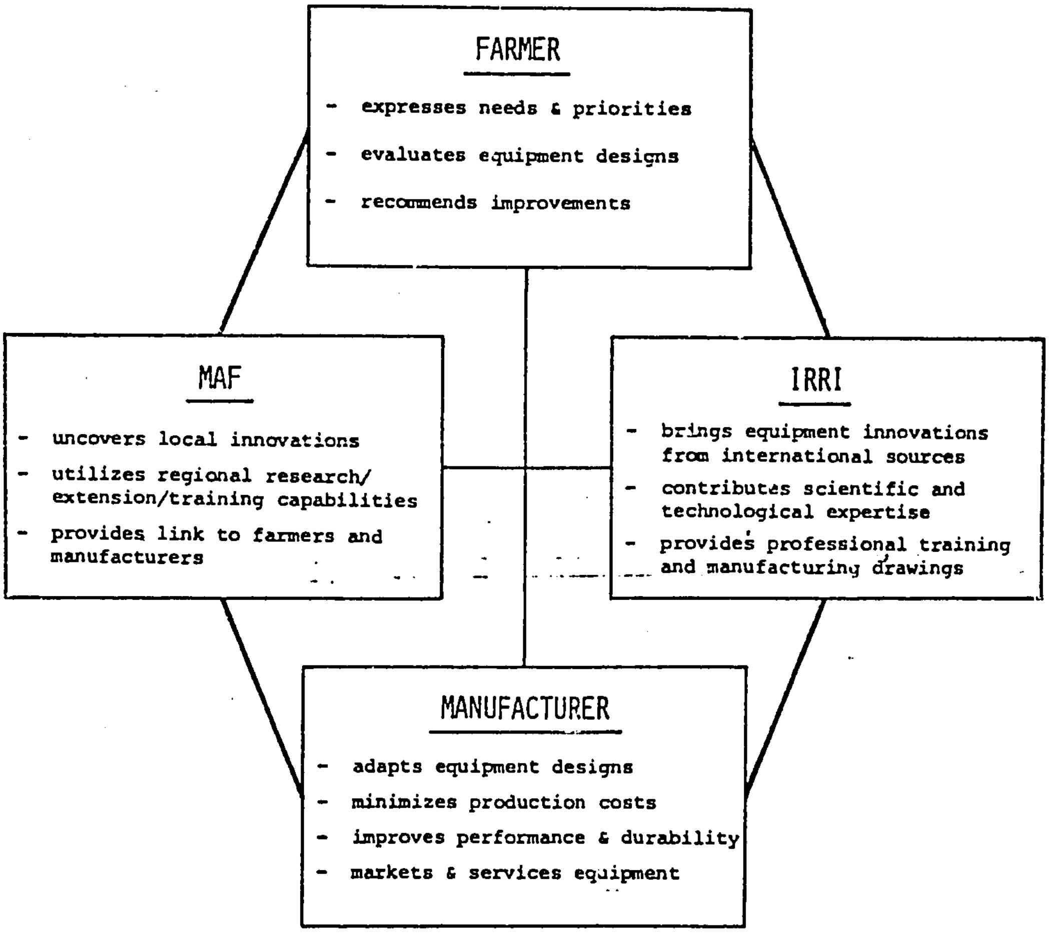


Figure 1. Collaborative relationships of the MAF-IRRI Program for Small Farm Equipment.

The Program has been designed to utilize existing government personnel and infrastructure, thereby reducing cost and increasing efficiency. The principal participants are:

(a) Engineering Division, MAF Bureau of Plant Industry, Manila, for overall coordination of R&D and extension;

(b) Regional engineers (one in each of the 12 MAF Regions), who provide direct contact with manufacturers and farmers;

(c) Other institutions, such as the Small Business Advisory Centers (SBAC) of Ministry of Trade and Industry; the National Irrigation Administration (NIA); the National Food Authority (NFA); the Agricultural Mechanization Development Program (AMDP).

The Program has established the on-going process of research, development, and extension shown in Figure 2. The process begins and ends with the FARMER.

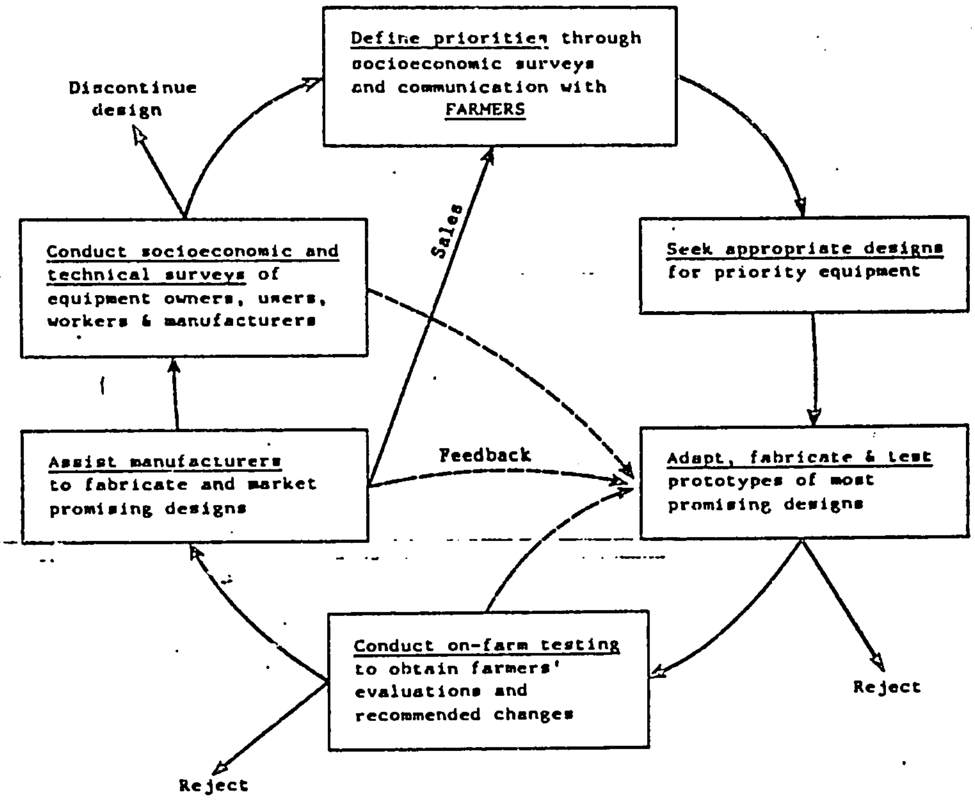


Figure 2. Research/development/extension process of the MAF-IRRI Program

One of the most effective extension activities is the loaning of prototype units of MAF-IRRI equipment to interested manufacturers. Since the majority of the Program's manufacturers are not able to fabricate new designs solely from the engineering drawings, prototypes are essential aids.

4. <u>Hydro-Tiller</u>. Filipino inventors have sucecssfully developed and marketed a floating rototiller for tillage of waterlogged rice fields where the mud is too deep for the conventional power tiller or carabao. At the request of the Liaison Engineer, IRRI carried out a technical and economic study which found that this tiller can substantially reduce land preparation costs and turnaround times, even in fields having normal soil and water conditions. However, existing designs generally have two problems: (a) the tiller's belly leaves a furrow which is difficult to level and also reduces the rate of decomposition of stubble, straw and weeds; and (b) tiller operators complain that strenuous effort is required to control the forward speed and to maneuver turns. Arrangements were made for IRRI and MAF engineers to collaborate with cooperating manufacturers to develop the hydro-tiller which reduces both problems by utilizing two pontoons having V-shaped bows and flat bottoms. A current project is the development of a multi-purpose ("transformer") tiller which serves both as a conventional tiller as well as a hydro-tiller.

These four cases illustrate different ways in which MAF and IRRI have worked together to achieve practical results which most likely would not have been attained by either institution without the collaboration of the other. As indicated in cases 2, 3 and 4, the collaboration of innovative manufacturers and farmers was an essential element.

IV. BRIEF SUMMARY OF RESULTS

MAF staff:

- 25 attended IRRI training
- 19 currently participating in Program
- collaboration with four farming systems projects

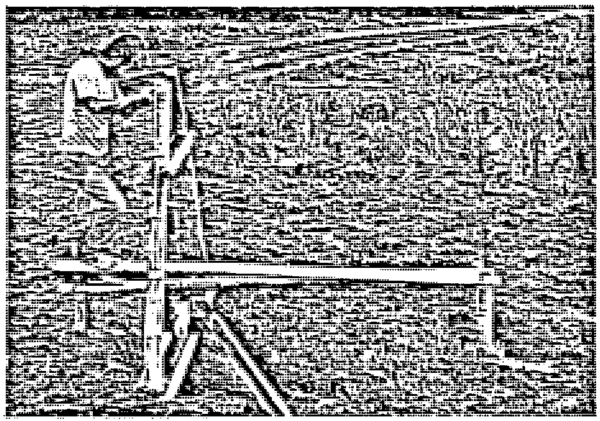
Manufacturers:

- 200+ have joined Program
- Located throughout country -- from Aparri to Zamboanga (Figure 3)
- Requested and received:
  * 550 blueprints of MAF-IRRI equipment
  * 130 short-term loans of MAF-IRRI prototype equipment for testing and copying
- Received 1,800 technical assistance visits
- Participated in 3 training courses and 4 workshops
- <u>1985 sales</u> (survey of 70 manufacturers)
  * 350 pumps
  * 150 seeders & planters
  * 1,600 threshers & shellers

  } MAF-IRRI designs

This is only the beginning. Sales are increasing rapidly inspite of depressed economic conditions in the country. Moreover, innovations by cooperating manufacturers have increased due to motivation and experience gained through Program.

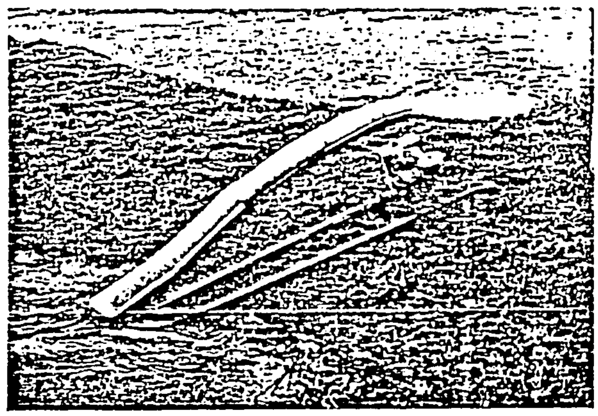
EXAMPLES OF MAF-IRRI EQUIPMENT DESIGNS



TAPAK-TAPAK PUMP

- Innovation from Bangladesh where sales surpass 40,000.
- Adapted to Philippines for small farms in rainfed areas.
- Low cost (US$30 to $65).
- Increases farm employment and income during dry season.
- Easily fabricated by small shops with common tools and materials.

SIPA PUMP

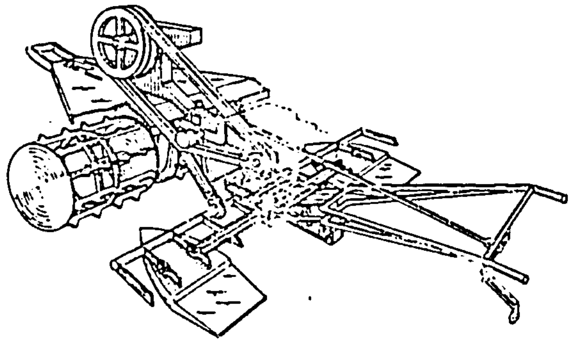


- Original design from Indochina.
- Filipino innovations reduce price to US$45 - $75 (excluding engine).
- Scientifically designed propeller for high pumping efficiency.
- Ideal for small rice farms and fishponds.
- Far more economical than centrifugal pumps for low-lift applications.

HYDRO-TILLER

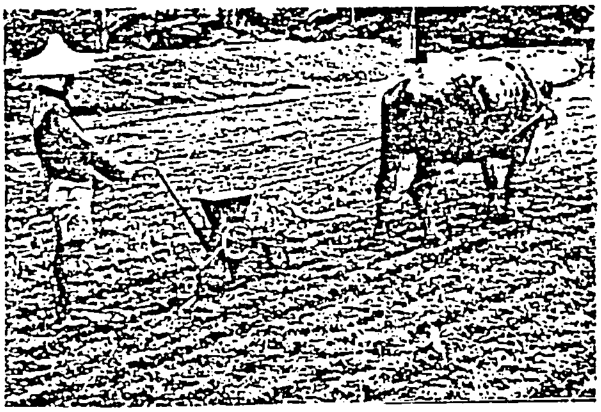
- Improvement of popular Filipino innovation.
- Reduces cost and time required for tillage of rice fields, thereby increasing income, cropping intensity and timeliness.
- Thorough puddling and incorporation of weeds, straw and green manure.
- Suitable for waterlogged areas where conventional tillage equipment cannot be used.

TRANSFORMER TILLER



- Combines best features of conventional and hydro-tillers.
- Multipurpose machine at small increase in price (10 to 15%).
- Higher capacity than conventional tiller; more versatile and transportable than hydro-tiller.

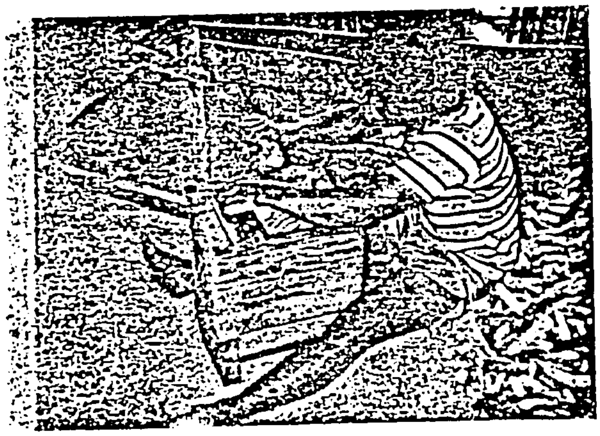
ZERO-TILL PLANTER



- Adaptation of proven high-tech design from New Zealand.
- Effective for planting dry-season crops (beans, corn, peanuts, etc.) in rainfed rice fields.
- Places seeds at proper depth with good soil & moisture environment.
- Avoids costs and delays of tillage, thereby increasing profits and maximizing utilization of residual moisture.

THRESHER/SHELLER

- Modification of popular IRRI-designed thresher to serve also as corn sheller.
- Result of innovative collaboration with manufacturers to meet needs of government corn program.
- Increases machine prices by only 5 to 10%.
- Quickly and easily changes from thresher to sheller.

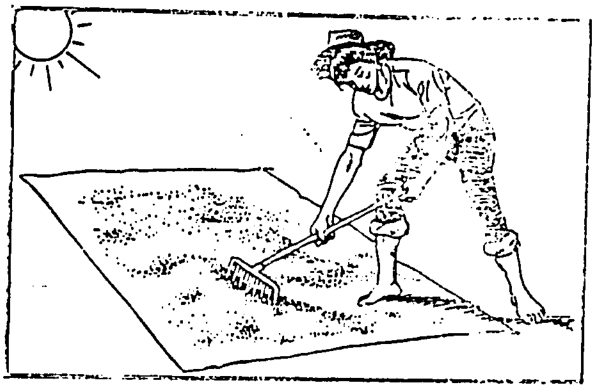


HAND-OPERATED SHELLER

- Based on design developed in Zamboanga del Sur.
- Easily fabricated in small shops with local materials and tools.
- Low cost (US$15 to $20).
- Ideal for small-scale corn farmers who cannot afford machine-powered shellers.

IMPROVED SUN-DRYING

- Substantially reduces amount of broken grains appearing in milled rice.
- Easily used with only small increase in labor.
- Utilizes locally-available materials and tools.
- Enables farmers to obtain higher prices for paddy.



Other MAF-IRRI equipment designs:

Lightweight hand tractor; rice seedling transplanter; direct seeders; seed and fertilizer applicator; paddy weeder; cultivating/weeding implements; rootcrop chipping machine; reaper attachment for hand tractor; paddy dryer.

ANNEXURE 2A

PROGRAM DESCRIPTION

USAID-IRRI-MALAGASY RICE RESEARCH PROJECT

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IRRI MALAGASY RICE RESEARCH PROJECT

PROGRAM DESCRIPTION

INTRODUCTION

This project represents the second phase of activity which involves IRRI scientists with the National Rice Research team in a systematic procedure for evaluating and purifying the national rice collection, introducing improved germ plasm into the country's rice breeding program and developing improved cultural practices based on rice-based cropping systems. The original goal "to improve rice production on farms in Madagascar" remains unchanged. The original purpose to develop an institutional mechanism for the exchange of information and materials between IRRI and the GDRM rice research institution" is modified in this amendment to reflect the operational role that IRRI has taken on as an integral element within the National Rice Research team. No longer is the project purpose limited to institutionalizing information and materials exchange, but more accurately it is using such an institutional mechanism to carry out effective rice research in Madagascar in the context of a rice-based cropping system. This also requires a modification at the output level as well as fairly substantial changes in the proposed mix of inputs.

The five outputs of the original activity remain effectively unchanged.

1. Selection of pure varieties within the existing collection of germplasm material adaptable to irrigated and upland conditions;

2. IRRI germ plasm tested for adaptability to irrigated and upland conditions;

3. Continuation of a system for the exchange of information between IRRI and the GDRM rice research institution;

4. Commencing implementation of a country rice research strategy plan for the long term development of the rice research institution;

5. Trained personnel for the rice research institution.

To these, are added a sixth output: Rice research undertaken at the Center and selected regional stations using a rice-based cropping system context.

Project inputs include technical assistance, training and commodities provided by AID supported by construction costs and other local costs provided by the GDRM. The proposed level of technical assistance is generally consistent with the first phase, i.e., two long term resident experts, although the amount proposed for consultancies has been substantially expanded based on experience in the first phase. Given the amount of construction activity as well as the increased amount of procurement proposed in this phase. IRRI believes it will require the assistance of a locally recruited administrative assistant for the period of one year. Technical consultancies will be in appropriate areas including weed science, rice breeding, farming system research, water management, soils chemistry, etc.

The proposed training levels are also consistent with the first phase with the same number of short term trainees being sent to IRRI and a few more opportunities to attend international technical seminars. Short term trainees will be sent to follow courses in such study areas as soils science, agronomy, phytopathology, and entomology. A major increase in training funding is required to commence the training of two scientists at the advanced degree level who will be prepared for phase out of a long term resident experts. Current staff involved in rice research appear to be adequate for the level of proposed research. These include 6 researchers at the Ph.D. level and 12 technical associates at the M.S. level. FOFIFA's plan calls for hiring additional personnel, and both the budget and qualified applicants are available.

The greatest increase in the project budget from the first phase comes in the commodity section, reflecting the evolution from initial institutional linkages between IRRI and GDRM to involvement of IRRI and the GDRM is commencing implementation of rice research in the context of rice-based cropping systems. Commodities will be used to:

a) equip the national rice research facility at Mahitsy being constructed by the GDRM;

b) provide basic equipment to three regional (and climatically different) rice research stations;

c) provide required farm equipment to support rice research activities, and

d) provide appropriate and required transport for rice research operations including monitoring farmers' field trials.

The GDRM will provide funding for construction required for the rice research activities at the regional centers and will support all local costs of the project.

PROJECT DESCRIPTION

The original project description remains substantially correct. The evaluation completed in November 1985 verified that the original activity paper still reflected the reality on the ground. The major objective of creating a workable mechanism linking the GDRM and IRRI in a joint effort to improve the professional skills and institutional capacity for conducting relevant rice research will in this second phase be tested by implementing rice research in the context of a rice-based cropping system. To indicate the GDRM's priority for rice research, it is instituting a separation of agricultural research activities to be based by crop type. Rice will have its own research facilities as well as its own staff which will work exclusively on rice rather than on several crops on a part time basis. The FOFIFA rice strategy document indicates available staffing, staff quality, training requirements, equipment requirements, planned construction of facilities, and expatriate technical assistance requirements. These plans were reviewed by the evaluation team and found to be reasonable and appropriate.

The lack of adequate GDRM quarantine procedures for rice germ plasm has plagued the IRRI researchers from the outset. Progress has been made and procedures are now at the minimum acceptable level for current rice breeding activities. IRRI is hopeful that continued training and visits by GDRM to IRRI headquarters to observe phytosanitary procedures will result in streamlining quarantine procedures as more rice breeding stock is required. It is not felt that inclusion of a condition precedent on GDRM quarantine procedures would serve any useful purpose since this is outside the control of IRRI and procedures are now marginally adequate.

COST ESTIMATES

The project will require funding from AID in foreign exchange and from the GDRM in local currency. The foreign exchange cost estimates are based on actual costs incurred in the first phase as far as technical assistance and training are concerned. Commodity costs are based on the best available estimates. GDRM funding will be drawn from two sources, regular budget allocations which will cover local personnel salaries and routine operating costs, and PL480 generated local currency which will provide for construction costs and any extra-ordinary operating costs associated with the presence of the IRRI team. The table below present the proposed budgets for this phase of the project, and are followed by an overall budget table showing the costs of the project to date.

TABLE I

IRRI MALAGASY RICE RESEARCH
A.I.D.
Phase II $'000

COMPONENT	UNIT	PY1	PY2	TOTAL
I. TECHNICAL ASSISTANCE				
Long term Agronomist	24 pm	120	120	240
Rice Breeder	24 pm	120	120	240
Admin. Assistant	12 pm	30	-	30
Short term	36 pm	110	130	240
II. TRAINING				
Long term	6 py	75	75	150
Short term/IRRI	80 pm	80	220	300
Seminars & Workshops	10	36	36	72
III. COMMODITIES				
Equipment	Annex F	100	140	240
Vehicles	23	108	152	260
Farm equipment	Annex F	40	70	110
Shipping	@ 40%	84	115	199
IV. Contingency/Inflation	@10%	97	102	199
TOTAL		1000	1280	2280

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TABLE II

IRRI MALAGASY RICE RESEARCH

GDRM

COMPONENT	UNIT	PY1	Phase II PY2	Equiv. $'000 TOTAL
Personnel		183	225	408
Operating Expenses		83	73	111
Training		0	17	17
Construction		1166	1166	2332
Equipment/Supplies		92	130	222
Contingency/Inflation	@ 20%	296	322	618
TOTAL		1175	1933	3708

TABLE III

OVERALL PROJECT COSTS PHASE I AND II

$'000 &
$'000 Equiv.

COMPONENT	PHASE I * FX	LC	PHASE II FX	LC	TOTAL FX	LC
TECHNICAL ASSISTANCE	668		750		1418	
PERSONNEL		320		480		728
TRAINING	148	14	522	17	670	31
COMMODITIES	150		809		959	
EQUIPMENT/SUPPLIES				222		222
CONSTRUCTION		652		2332		2984
OPERATING EXPENSES		112		111		223
CONTINGENCY/INFLATION	234	109	199	618	433	727
TOTAL	1200	1207	2280	3708	3480	4915

* Note: Phase I costs set forth above represent estimated expenditures under previous IRRI Grant No. 936-4111-G-00-4001-00 expended during the Grant period 20 February 1984 through 20 August 1986.

IMPLEMENTATION ARRANGEMENTS

The implementation arrangements made for the first phase will remain the same as far as utilization of dollar funding is concerned. While some coordination problems occurred at the beginning, implementation relationships are now working smoothly. Regarding procurement activities, IRRI is fully familiar with AID procurement regulations and sees no difficulty in procuring the substantial amount and range of equipment proposed in this phase.

A pattern of long delays in the availability of local currency has hampered the effectiveness of the IRRI team. The AID office in Antananarivo is currently attempting to arrange for streamlining local currency disbursements with the GDRM and anticipates success. Should this problem not be overcome by the time of the signature of the grant agreement for the FY 1986 MARS project amendment, the local AID office intends to put a condition precedent on disbursement of funds for commercial imports (approximately $2.2 million of a $2.8 million amendment).

Implementation Schedule:

The implementation schedule for the IRRI grant is necessarily controlled by the seasons and the availability of participants to send for training. As the original activity paper's implementation plan was primarily notional but served to list kinds of activities, the same could be provided for Phase Two. Possibly the only concern in doing this is to assure that the required equipment arrives on a timely basis, as there are only sufficient funds in the first year of phase two to procure approximately half of the amount required.

ANALYSES:

The original project documentation constituted a sub-activity of an overall S&T Bureau grant to support International Agricultural Research Center (IARC) activities. As such it was not subjected to the requirements of a rigorous series of analyses which might be expected in a standard project paper, nor is this phase. Nevertheless, there are several appropriate comments which should be recorded. The initial IRRI visit made in 1982 indicated that a significant crop production response to research could be expected, especially in Madagascar where no new breeding material had been introduced since the 1970's. Production increases in the order of 15% due to improved seed alone could be realized once seed was available in sufficient quantities for distribution. Thus in the context of two million tons (annual Madagascar rice production) a 15% increase would be a very dramatic return to the nominal investment in research represented by this project. It should also be noted that this phase of activity intends to pursue rice research in the context of a rice-based cropping system. Such an approach assures that micro-economic and socio-cultural considerations are taken together with technical considerations in determining the optimal rice seed.

EVALUATION

This second phase of activity should be evaluated after the completion of 20 months of implementation, i.e., about January 1988. The evaluation should focus on the extent to which IRRI and the GDRM have been successful in undertaking rice research in the context of a rice-based cropping system. The evaluation should also make recommendations concerning the appropriateness and the extent of IRRI involvement in a future phase.

Period of Grant

The effective date of this Grant is August 21, 1986. The expiration date is August 20, 1988.

Amount of Grant and Payment

AID hereby obligates the amount of $1,000,000 for the purposes of this Grant.

Payment shall be made in accordance with procedures set forth in Attachment 3, Standard provision entitled "Payment - Periodic Advance".

Financial Plan

The 1,000,000 obligated hereto is expected to be used for those items of project expense that must be met with foreign exchange, i.e. foreign to Madagascar. The Government of Madagascar has agreed to furnish funds to meet project expenses that will be paid in FMGS.

ANNEXURE 2B

REVIEW OF PROGRESS

USAID-IRRI-MALAGASY RICE RESEARCH PROJECT

MADAGASCAR-IRRI RICE RESEARCH PROJECT[1/]
REVIEW OF PROGRESS
(AUG.1984-JULY 1986)

J. R. HOOPPER and B. B. SHAHI[2/]

INTRODUCTION

Rice is the staple food of the Malagasy people who have one of the world's highest per capita consumption of the grain, about 156 kg milled rice per year. Approximately, 2,177,000 MT of rice were produced in 1985 which was insufficient to meet the rice needs of the 10 million population. The demand for rice increases 30,000 MT per year which reflects the 2.8% population increase. But, in fact, rice production has remained stagnant or even decreased over the past 20 years (Table 1).

Rice imports were between 150,000 and 190,000 MT per year between 1978 and 1981, reached a peak of 351,000 MT in 1982, and declined to 104,000 in 1985. However, rice imports do not meet the demand (Table 1).

Although reliable statistics are not available, it is thought that rice is grown on approximately 1.2 million ha, which is 35-50% of the permanently cultivated land. About 70% of the population is involved in its production.

Between 70 and 80% of the total paddy cultivated area is made up of small-holder paddy fields, and the remaining 20-30% represent organized irrigation shemes developed and supported by the government.

Rice yields average 1.7-1.8 t/ha. Rice yields have failed to increase over the past 10 years. This decline is due to several factors, such as marketing policies, low price of rice

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1/ USAID Grant 436-4111

2/ Team Leader - Agronomist and Plant Breeder. BP 4151 Antananarivo, Madagascar, presented by SHAHI.

and also, prices of fertilizers rose dramatically in the middle 1970s and they became both unavailable and unaffordable. Credit opportunities diminished.

It is also true that rice yields failed to increase because of the lack of development of improved rice technologies by research institutions. A depressed economy resulted in severe cutbacks in government spending which greatly decreased research and extension activities. Thus, the rice recommendations of 1986 are virtually the same as that recommended 15-20 years ago and few farmers today are following them. There has been little or no introduction and testing of new rice germplasm in the past 7-8 years. In the past 10-15 years comparatively little research has been conducted on research stations and technologies evaluated under the farmers' field conditions.

The government's goal is to reach self-sufficiency in rice by 1990. This will require radical changes in economic and farmer favouring marketing policies, which in fact, have been and are continuing to be effected. It will also require a greatly revitalized and reorganized rice research effort to test, evaluate and identify more productive technologies which farmers can adopt.

In this context formal agreements were signed between IRRI and the Government of the Malagasy Democratic Republic on October 29, 1982 and between USAID and IRRI on February 17, 1984 providing for the assistance of IRRI in strengthening the research capabilities of the National Center for Applied Research on Rural Development (FOFIFA). This would be accomplished by linking the expertise of IRRI into FOFIFA's on-going rice breeding and agronomic programs, for improving the professional skills of FOFIFA researchers and the institutional capacity for conducting relevant research on rice and rice-based cropping systems.

Five short-term outputs have been identified to be attainable during the life of the 2-1/2 year project. In facts it has completed 2 years on August 20, 1986. These are

(1) selection of pure varieties within the existing collection of germplasm adaptable to irrigated and upland conditions,

(2) introduction and testing of elite germplasm from various sources through international centers, for adaptability to irrigated and upland conditions,

(3) development of a system for the exchange of information between IRRI and the Malagasy rice research institution,

(4) completion of a country rice research strategy plan for long-term development of the rice research institution,

(5) training personnel for the rice research institute.

PROGRESS TO DATE

NATIONAL RICE TEAM

The National Rice Team was placed under the leadership of Dr. Ravohitrarivo Pascal, the Director of Scientific Research, FOFIFA in May 1985 only. Since then, the team itself was expanded to include not only agronomists but also scientists from Department of Research and Development (socio-economists), Department of Research Technology (irrigation and mechanization), and representatives from the Ministry of Agriculture's Crop Protection Service (PSV), Seed Production Division, and vularization division. These changes have resulted in better coordination and integration within the Department of Agronomy but also between FOFIFA and MPARA divisions. Such positive interactions assist in creating opportunities for conducting mutually beneficial cooperative activities which can accelerate the flows of technology from researchers to farmers. The National Rice Team also serves to keep institutionally diverse organizations informed of what is taking place in the field of rice research, technology generation, infrastructure etablishment and critical mass of of trained man power development.

EXCHANGE OF INFORMATION BETWEEN IRRI AND FOFIFA

Contact with other rice scientists through workshops, conference, and monitoring tours is and will continue to be very important to the development of FOFIFA scientists. These contacts expose them to new and different ideas, procedures and agricultural technologies and moves them into the international stream of rice science. FOFIFA scientists have participated in one or more conferences to date. A list of FOFIFA scientists who have participated in rice conferences and workshops are detailed in Table 2.

Training of FOFIFA scientists in IRRI's short'term courses and especially arranged programs is progressing well. Scientists have been or are in the process of being trained (Table 3). We also arranged for three extension officials to follow the 2-week rice production training during August, 1985.

A number of IRRI scientists have visited Madagascar to address some of FOFIFA's research concerns. Dr. Loevisohn was in Madagascar from October 1984 to September 1985 as a consultant to assess pest and disease problems of rice. Dr. D. M. Wood; Training and Technology Dept., visited June 29 to July 10, 1984 to look at training needs. Dr. V. R. Carangal, Coordinator of the Asian Farming Systems Network, reviewed farming system, cropping system and related problems of rice in Madagascar April 12 to 30. Dr. T. M. Mew visited Madagascar between April 16 to 26 to discuss and review the rice disease problems with FOFIFA pathologists and other scientists. Between October 1 and 3, Dr. Mamaril visited to review Madagascar's soil problems and INSFFER program. Mr. Nas Manalili, Agricultural Engineering Department, was in Madagascar November 17 to December 20 for assembling and demonstrating IRRI-designed machines and to survey farmer needs for simple equipment. Dr.

F. N. Ponnamperuma, former Head of Department of Soil Chemistry, IRRI visited Madagascar between February 14 and 28 to review the soils research program. Dr. Palis visited here between June 24 to July 4, 1986 for land development especially irrigation drainage and building structures layout in Mahitsy, irrigation and drainage layout in Ivoloina and Marovoay stations. Dr. Flinn and Mr. Manalili's second visit already completed. Dr. Flinn Head of IRRI's Economic Department conducted training with socio-economic apsect of analysis between June 29-17 July 1986 with DRD scientists and worked out some research needs. Oldeman's consultancy on climate-soil classification of rice environments started from July 1. Future consultancies will be hired for computer and statistics specialist.

IN-COUNTRY TRAINING

During February 1986 FOFIFA rice scientists conducted a two-week rice production training program to upgrade the knowledge and practical skills of 35 FOFIFA monitors, field assistants and laboratory assistants and five extension workers. Emphasis was on selection, establishment and management of field trials, and fertility and pest management.

STRATEGY REVIEW

We have worked with FOFIFA to prepare a preliminary document setting forth its rice research goals and strategies through the remainder of the 1980s. This document also indicateds FOFIFA's future material, more manpower and financial requirements.

QUARANTINE

Quarantine Service procedures require that all introduced rice be grown in pots from seed to seed. Because of the length of time to complete one life cycle (4-7 months) in the greenhouse and because of limited greenhouse space, the number of improved rices introduced since August 1984 has been low. Up to this time 450 rice have passed through the greenhouse and another 157 varieties/elite lines are still in the process of being screened.

Quarantine Service have had problems with too high and too low temperatures, too high humidity and soil problems (primarily iron and zinc deficiencies) which have led to poor seed set, poorly filled grains or death of the plants. We have been working with quarantine service to resolve these problems and have made some good progress in this area. Recently, an FAO quarantine consultant has begun working with the Quarantine Service.

RESEARCH NEED AND ACTIVITIES

Madagascar is 1700 km long and 500 km wide and lies between 12° and 26° latitude south. It possesses a range of rainfall, temperature, and soil types, and rice is grown at elevations ranging between see level and 1700 m. Permutations of these factors create a great diversity of rice growing environments, each pernaps requiring its own specific set of technologies.

IRRI is collaborating with FOFIFA in developing rice research programs in the High Plateau, Lac Alaotra, Tanandava, Marovoay, Kianjasoa and Ivoloina. These are six major rice growing regions which represent major rice environments, have potential for increased yield and are within the logistical resources of FOFIFA (Fig. 1).

There are two main thrusts to FOFIFA's rice research programs.

1. The cropping system program.
2. The variety improvement program.

CROPPING SYSTEM PROGRAM

The cropping systems program is conducting on-farm rice research in three areas: Betafo and Manjakandriana on the High Plateau and Kianjasoa in the Middle west area. Cropping System Research in other areas has not commenced because of a lack of agronomists.

The cropping system research consists of two components: cropping pattern design testing which seeks to identify more economically profitable rice based systems and component technology testing which tests the different management components of farmers' or "improved" patterns in two or three sites. The cropping pattern testing is carried out by farmers. Component technology testing is conducted by researchers.

During the 1984/85 season Agronomy initiated a small number of trials on-station and on-farm. Trials sought to identify techniques that would maximize the efficiency of low rates of fertilizer. Results of one trials (Table 5) indicated thatall 30 kg N applied at 30 DAT was superior to applying it all at either transplanting or PI. Split application between transplanting or PI. Split application between transplanting and PI was as good as applying all at 30 DAT.

FOFIFA agronomists also conducted trials at the Belanitra station to identify the best sources of P, the methods of applying P for maximum efficacity and the most economic level of P. Results of these trials were inconclusive because of heterogenity of the soil in 1984-85, however 1985-86 data at Manjakandriana shows that root dipping method was more economical than broadcasting (Table 6).

At Mahitsy, NPK, Zn and S trials were conducted. Data indicateds a good response to N, responses to Zn and K and no response to P and S. The fertility of Mahitsy station soils is fairly high because of continued applications of high fertilizer dosages over a long period of time. In a test conducted on farmer's field shows clear response of P good response of N and no response of K. The response of Zn and S was not significant at site No.1 (Table 7).

Because of the shortage and high cost of artificial fertilizer, FOFIFA scientists are seeking to use organic manure, animal manure and azolla a N source. Results of animal manure organic manure and fertilizers is discussed in Table 8.

Azolla trials indicated that addition of Azolla did not significantly increase rice yield in Mahitsy 1984-85 (Table 9). Azolla growth was poor and mid-season drought killed Azolla and stressed rice plants. However, in 1985-86 in Betafo with a 90 kg N and combination of Azolla gave significantly higher yield of rice (Table 10).

Cropping pattern research trials identified wheat as performing better than beans or potatoes. More variety screening work is needed on these crops at Mahitsy station (1270 m altitude).

The cropping systems program has initiated on-farm research in four areas: Mahitsy, Antsirabe/Betafo, Manjakandriana, and Kianjasoa (Middle West). Three of the four sites are located near research stations to facilitate logistic demands.

Cropping systems research have been conducted in both wetland and upland environments. In Kianjasoa and Manjakandriana cropping pattern trials are being supervised by researchers but managed by farmers during 1985-86 season.

Component technology trials at the site are addressing what the collaborating scientists feel are the most important agronomic constraints to increasing yields. Some of the trials being conducted on farms are:

--time and frequency of applying low dosages of N (Manjakandriana, Mahitsy, Betafo)

--identification of major soil constraints (Kianjasoa = upland, Manjakandriana, Mahitsy)

--variety adaptation trials (Manjakandriana = 2 soil types; Kianjasoa = upland and wetland)

--methods, sources and levels of P application (Belanitra, Mahitsy, Manjakandriana)

--time and levels of N application (Kianjasoa = upland)

--Multiplication and incorporation of various species of azolla obtained from IRRI and locally available species.

--Multiplication and incorporation of Green manure crops such as Vicia, Vetch, Sesbania etc.

--Introduction of legume crop in cropping system

In addition a number of INSFFER trials have been initiated at Belanitra (long term) and Mahitsy (long term; organic and inorganic) and on farmers' fields in Betafo (organic and inorganic sources).

Because of the unavailability and high price of fertilizer, FOFIFA scientists are conducting research to determine the best management practices for growing Azolla on the fertile soils of Betafo.

Cooperative multilocation fertilizer trials were designed and are being conducted by FOFIFA agronomists, Ministry of Agriculture extension service, and FAO. This is the first time that FOFIFA has been directly involved in developing the treatment for these trials.

Comparison of supper granule and urea a source of nitrogen at different location on farmers' field is discussed in (Table 11).

VARIETY IMPROVEMENT PROGRAM.

Variety improvement program consists of three main aspects.

a) Collection, purification, evaluation and preservation of local Malagasy varieties.

b) Introduction of desired varieties and lines.

c) Hybridization work.

a) Collection, purification, evaluation and preservation:

1. Objectives

- Conservation of local germplasm before elemination by high yielding varieties.
- study the yielding ability, disease, insect resistance, quality and other physiological stresses.
- Select most adapted varieties for hybridization work for higher yields and other components.

2. Organization involved:

- FOFIFA, IRRI and IPBGR coordination.

3. Program:

- FOFIFA with the help of IRRI and IPBGR trying to collect varieties from all major rice growing areas of Madagascar.
- Purification, evaluation, characterization, preservation at IRRI, England and FOFIFA.
- Building Germplasm Center and providing required equipments.

4. Progress:

- IRRI Field Collector helped two times out of 6 collection trips.
- 476 local varieties are being evaluated for 42 characters and being purified at FOFIFA.
- At IRRI 231 varieties have been characterized so far.
- 460 varieties at IRRI are being under the process of characterisation and identification for duplicates samples.

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- 219 varieties which originated from Madagascar but received from different countries are being in the process of identification for duplicates samples and characterisation at IRRI.
- FOFIFA plant physiologist used 181 varieties of Madagascar at IRRI for cold tolerance studies found 19 cultivars good level of tolerance and 39 showed good recovery percentage from cold.
- At IRRI 118 varieties were analysed for glutine, protein and 1000 grainweight, and 32 varieties were tested for blast resistance.
- At present these varieties are being evaluated for high plateau condition in Antananarivo and tropical condition at IRRI.

5. Constraints:
   - Manpower, building and equipments.
   - Need to be grown every year in Madagascar for preserving germination of seed samples.

6. Prospects and Possibilities:
   - construction and equiping of germplasm center by IRRI and IBPGR respectively.
   - Malagasy varieties could be disease, insect and other physiological stress tolerant gene source.

b) Introduction.

1) Objective:
   - Introduce high yielding varieties and lines for various ecologies such as, irrigated, rainfed, upland, deepwater, salt tolerance, cold tolerance, iron toxicity, phosphorous and Zinc deficiency and for low pH conditions of organic and mineral soils in order to raise rice production in Madagascar.
   - Introduce segregating materials and advance lines for quick

adaption as varieties to minimize breeding and selection time.

2) Organization involved:

- FOFIFA, IRRI, IRTP, IRGC, IRAT and Quarantine Service.

3) Program:

- Introducing varieties from IRGC, IRRI, IRTP and other sources.
- Grow one cycle (4 to 7 month) in Quarantine glasshouse.
- Multiply the few grams of seeds obtained from Quarantine service in coastal area.
- Test the varieties and lines in rod row trials in different ecological areas of requirement for disease and insect pressure as well as yield and other characters as compared to local cultivars (Table 12).
- Evaluated in replicated trials for 3 years at different stations according to ecologies (temperate, semitropical and coastal area) before recommanding for testing in farmer's field and finally for general recommandation.
- Use of high yielding, diseases and insects resistant introduced varieties in hybridization work with local varieties for general adaptation.

4) Progress:

- 450 varieties are passed and 157 are being screened by Quarantine Services.
- Out of 450 varieties 228 varieties were tested in rod row and replicated trials according to ecological need in 1985/86. These varieties and lines were tested in Marovoay in north west coast, Belanitra, Mahitsy, Viananinony Antsirabe, Fianarantsoa in high plateau, Ivoloina in East coast, Kianjasoa in middle west, Samangoky in south west and Lac Alaotra region.
- 110 varieties and lines were multiplied during this 1985/86 in Ivoloina and 19 varieties were distroyed by Typhone in March 1986.

- 106 varieties are in process of multiplication and are transplanted July 25, 1986.
- 157 varieties and lines are under testing in quarantine glasshouse planted in May and June 1986.
- So far some varieties introduced from IRGC and IRTP have performed well with many advantages and the results are reported in respective region and are given in Tables.

5) Constraints:

- space and glasshouse facilities are poor in quarantine service as described earlier.
- Insects such as white stemborer (Maliarpha separatella) rice hispa (Trichispa sericea) in high plateau and (Hispa gestroi) in east coast, Lac Alaotra and south west coastal region, root feeding insects (Heteronychus spp.) in upland areas, are endemic of Madagascar and all introduced varieties need a through screening.
- Similarly diseases such as sheath rot (sarocladium oryzae) a fungal disease which is susceptible to introduced varieties in high plateau and coastal area, leaf streak (Xanthomonas translucens) and blast (Pyricularia oryzae) are important and need throughly screened before using these varieties in breeding program and in also replicated trails. Most of these diseases are endemic to Madagascar with different race pattern to that of Asia. Sheat rot is not important disease in Asia which could be serious here.
- Some of the disease are not officially recognized of its existance however old litarature describe them and IRRI pathologist have seen them (Sheat rot).
- Some disease is confused with nematodes.
- There is need of full time pathologist working on rice bacteria, funguses and viruses.
- Pathologist concentrate studies on weeds only at present.
- Most of areas in high plateau is unique in low pH (acidic)

phosphorous deficient, iron toxic and susceptible to low temperature, prevenance of mineral and organic soil which is again very endemic situation as compared to other rice growing countries. Some screening techniques can not be adapted here and need to be identified new techniques pertaining to local situations.

6) Prospects and possibilities:

- Recently International Rice Germplasm Center has provided varieties tolerant to acid aerobic soil, zinc deficiency, aluminum toxicity, salt, alkanity, zerofertilizer, peat soil, boron, phosphorous deficiency tolerant varieties and lines.
- We have identified suitable soil areas specially for phosphorous defficient, iron toxic and low temperature, organic and mineral soil in Manjakandriana and Mahitsy region. Testing work will be started in 1986/87.

c) Hybridization work.

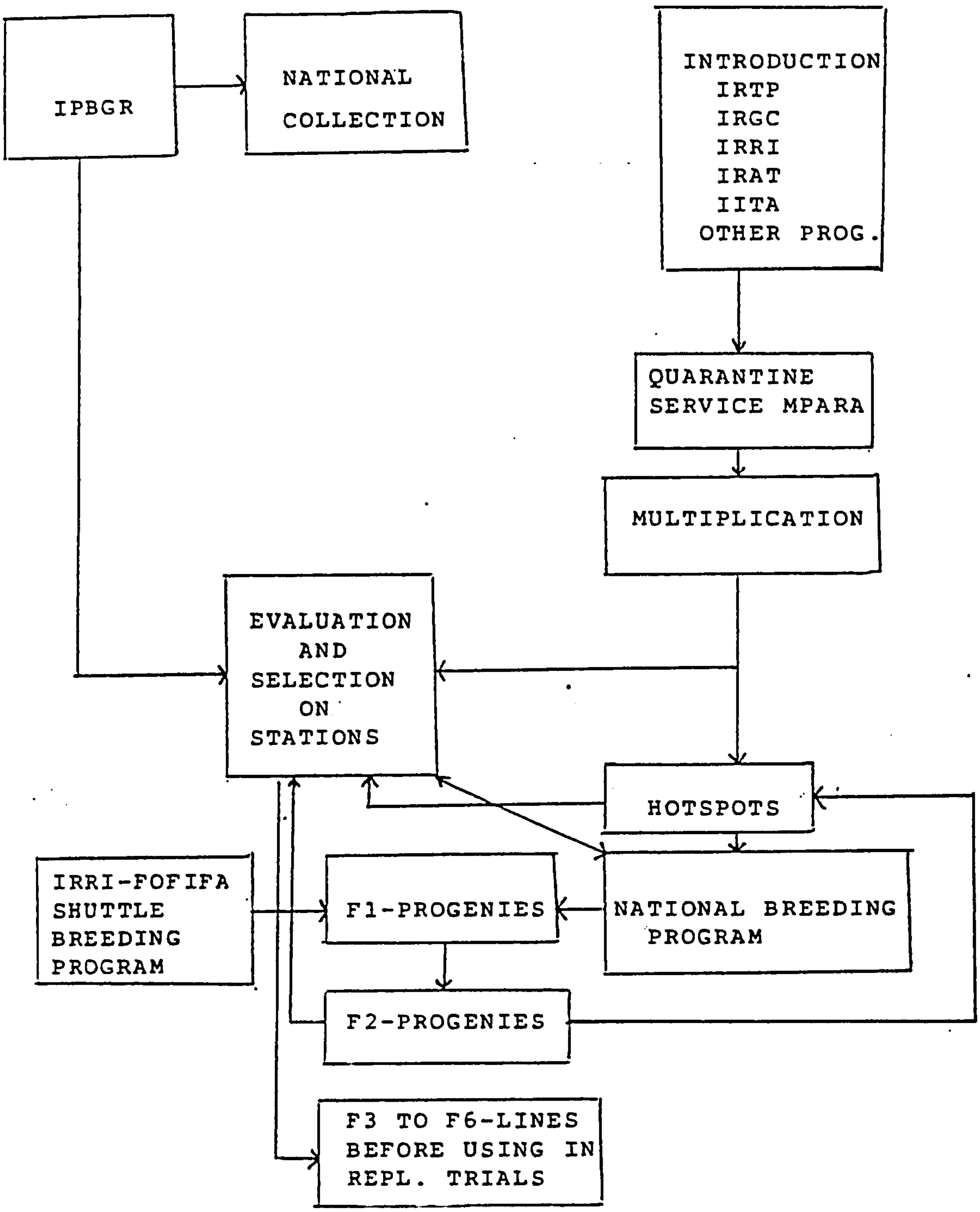
In future this would be most important part of breeding prgram. Instead of introducing large number of varieties and lines only important gene sources would be needed and varietal requirement will be tailored according to the regional need.

1. Objectives:

- Breeding varieties for higher yield with hihger nutritional values. Resistant to disease and pest. Suitable for the irrigated or better water control and easy inputs supply areas so as to make stable harvests.
- Breeding varieties for higher yield with ratooning ability for grain yield and higher biomass production (for animal feeds) in rainfed areas where monocropping is traditional because of poor drainage.
- Breeding high yielding varieties for upland areas with blast, *Heteronychus* spp. and nematode resistant.

- Breeding high yielding varieties for tidal wetland rice and adverse soils condition.
- Breeding high yielding varieties for deepwater areas.
- The objectives would be modified to meet the varietal requirements according to the constraints mentioned in section of "introduction of varieties".
- In breeding varieties for the existing cultural types and ecologies such as temperate, semitropical, tropical dry and tropical wet areas will be taken into consideration for varietal requirements.
- To minimize time and losses due to disease and pest only highly resistant introduced varieties with proper evaluation would be used in the breeding program.

2) strategies - The strategies are explained in the following schematic diagram.



RELEASE OF FIRST BRED VARIETY BETWEEN 6 TO 10 YEARS

3. Progress:
   - F_1 crosses of 6 families which include varieties like Tche Kouai, Chainan-8, Makalioka-34, Racishiko, Mahsuri and Molotry Ramadama for irrigation condition.
   - F_2 about 20 population
   - F_3 about 350 lines
   - With the constructions of facilities volume of crosses will increase substancially for other ecologies also.

4. Possibilities:
   - Cooperation besides with IRRI could also be obtained with IITA and IRAT and Brazil for upland breeding program specially.

5. Constraints:
   - In the absence of artificial facilities for disease and insect resistance screening of varieties totally depends on natural environments which takes long time (some time may not show true resistance or could scape from disease and insect pressure) before varieties could be used for definit purpose with high percent of accuracy in the breeding program.
   - Establishing new screening techniques such as for iron toxicity tolerance in low pH soil with low temperature regime is major concern in high plateau region. Similarly establishing other techniques for different ecological areas need to be mentioned here.

HIGH PLATEAU

GEOGRAPHY.

The high-plateau rice-growing region is located in the central part of the island and is characterized by numerous hills interspersed with small cultivatable plains and valleys. Rice is cultivated primarily between 1200-1500 m but small rice growing extend up to 1700 m. Rice is cultivated on 300,000 ha.

Climate.

Mean rainfall ranges between 1200 and 1700 mm, averages 1450 and falls mostly between October and April. The peak of the rainy season is December-January (250-325 mm/month) and the dryest months are June-September (5-20 mm/month). Rainfall distribution for important locations are presented in Fig. 1.

Rice is grown primarily during the warm months October through May. Low temperature between June and September (max. 20.3°C, min. 8.7°C) restrict rice growth during these months. Rice sterility is increased by temperature less than 15°C during flowering season.

Soils.

The central mountain range consists of granite and gneisses with some volcanic outcroppings. The predominate soils are ferralitic clays which have variable, but generally low, soil fertility. They are usually low to very low in P, organic matter, cation exchange capacity and pH. P and N are usually the most widespread limiting nutrients, followed by K, S and possible Zn (Table 13). Valley bottoms and some plains are often peaty because of poor drainage or seepage of water from adjoining hills. Iron toxicity is widespread perhaps due to the low CEC and pH and exacerbated by low temperatures.

The farmers in the high plateau apply more fertilizer than any other rice farmers. In 1985, 13,500 tons of fertilizer (mostly 15-15-15, 11-22-16 and urea) were made available and used by farmers in the high plateau. This averages to 5 kg N, P_2O_5, and K_2O per hectare. This is the same amount used 18 years ago (Table 4).

Farmers grow primarily low yielding, long duration, photo-period sensitive varieties which often lack fertilizer responsiveness and tolerance to cold and soil stresses. Many are susceptible to major diseases and insects.

Average rice yields (1.7 t/ha) are constrained by:

- inherent low soil fertility
- low use of fertilizer inputs
- wide use of low yielding, long duration varieties
- poor water control resulting in insufficient water during dry periods or in continuous water flow or inundation when rainfall is too much. (The implications for timely transplanting, good fertilizer management and efficiency, good weed control, etc. are obvious)
- poor control of insects, primarily hispa and African white stemborer (*Maliarpha separatella*), and of diseases, primarily blast, sheat rot (*Sarocladium oryzae*), brown spot (*Helminthosporium*) and possibly nematodes.

Opportunities for increases in yield and crop intensification exist. Earlier maturing varieties could make possible double cropping in areas with good irrigation and drainage (Table 14). Earlier maturing ratooning varieties could also make possible a rice-ratoon crop with germplasm elite lines obtained from IRRI's breeding program (Table 12). High yielding varieties exist which have good tolerance to cold and soil stresses (particularly iron toxicity and P and Zn deficiency), so there is good potential for increasing main crop rice yields (Table 15, 16 and 17). Additionally there is considerable technical and economic potential for increasing cropping intensity through cultivation of non-rice crops such as triticale, wheat, beans, lentils, and potatoes after rice during the dry, cool season.

Upland Rice on the High Plateau.

It needs to be mentioned that a recent phenomenon has been the extension of rice cultivation to the uplands of the high plateau. No reliable estimates of the area exists. The dryland rice cultivation appears to be a response to the fact that farmers

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can no longer increase production from their wetland fields because better technologies are not available or not affordable for increasing yields. Yields of upland rice are fairly low because of the low soil fertility and because of lack of adapted varieties. The amount of dryland area which could be grown to upland rice is vast in Kianjasoa (Middle-West part of high plateau).

LAC ALOTRA (ALAOTRA LAKE) REGION

The Lac Alaotra region is a large depression to the northeast of the High Plateau and lies at an elevation of 800 m. This depression covers 150,000 ha of which 125,000 ha have potential for wet rice culture but of which 90,000 are now being cultivated to rice. This region is considered the major "rice bowl" of Madagascar.

Mean annual rainfall is 1200 mm but the total amount and its distribution is quite undependable from year to year. The rainy season commences early November and terminates in early May. Low temperatures and rainfall during the other months constrain double cropping opportunities.

Soils are alluvial or peats in various stages of evolution. They range from the very fertile to infertile with some of the peat soils having severe management problems. However, on the average, Lac Alaotra soils are more fertile than High Plateau soils which is reflected in Lac Alaotra's average yields of 2.4 t/ha.

Approximately 40% of the area receives fairly good irrigation, the remainder being rainfed or undependably partially irrigated.

About 30% of the land holdings are less than 2 ha, another 30% are 2-4 ha, and 40% are more than 4 ha. Average farm size is 3.6 ha. Because of the large landholdings, labor is a major constraint which determines poor yield because of late planting, late weeding and late harvesting.

Of the 90,000 ha, 60,000 are rainfed and 30,000 irrigated. Half of the rainfed area is broadcast dry-seeded and some of the irrigated areas are broadcast wet-seeded. The proportion of broadcast seeding depends on the rainfall amount and distribution at the beginning of the rainy season.

Nurseries are generally seeded November-January and rice is harvested in May and June.

Makalioka 34 variety is grown on 90% of the area. Makalioka 34 is photoperiod-sensitive, tall, pure-line selection released nearly 50 years ago. In 1984, Tche-Kouai, a weakly photoperiod sensitive, shorter stature variety from China, was made available to farmers. It has the yield advantage that when planted late, it out-yields Makalioka-34. Another potential variety is IR-36 which is earlier than Tche Kouai and equally good yielder (Table 19).

The 2.4 t/ha yields are moderately low primarily due to:

-- unavailability and low use of fertilizer inputs
-- use of long duration, lodging susceptible, photoperiod sensitive varieties, and lack of high yielding, improved varieties for problem soils
-- poor water control and/or undependable rainfall resulting in late planting or drought stress
-- poor weed control, especially in direct seeded rice
-- lack of control of the insects and diseases
-- lack of labor for timely performance of actual operations: land preparation, planting, weeding and harvesting.

The opportunities for increasing rice production in Lac Alotra ppear very good. Use of early maturing varieties could scape tress such as drought (Table 18 and 20).

Situated at the 800 m level, both many modern warm season varieties should do well. Improving weed control and using cultural practices to prevent late planting induced yield decreases (presently30-40%) appear feasible. The use of simple implements for land preparation, direct seeding in rows and transplanting to reduce the labor bottlenecks in these operations appears promising. IRRI engineer has demonstrated the IRRI designed implement in this area two times and again FAO has requested his help in manufacturing locally some implements such as seeding, harvesting and threshing machine at their cost. He will be visiting third time in October 1986.

IRRI varieties which have good tolerance to peat and problem soils may do well under the particular soil stresses found in Lac Alaotra.

On the well irrigated areas double cropping should be feasible with the use of short duration, cold tolerant varieties. Results are presented in Table 18, 19 and 20.

SOUTHWEST REGION

The Southwest is characterized by a semi-arid tropical climate. Rainfall averages less than 500 mm per year, 75% falling in the space of 3 months, December-February.

Average annual temperature is 25°C and temperatures are generally favorable for year-round production. However, cold winter temperature can cause cold stress (poor panicle exsertion) in sensitive varieties such as IR8.

The Samangoky soils are alluvial and have good fertility. Salinity (alkalinity?) is a problem in some areas and zinc deficiencies are suspected.

Rice is grown on about 5,000 ha in Samangoky (Tanandava area) where FOFIFA has its rice research station. The potential is estimated at 15,000 ha. Another 10,000 ha are cultivated in Morondava and 7,000 ha in Bezaha. Rice area is limited by soil type and by the amount of river irrigation water available. Poor maintenance of the irrigation delivery systems reduces water amount affecting cultivation area and management.

Traditional and improved varieties such as IR8 and CICA 4 are grown. Yields average 3.5 t/ha.

Constraints to achieving higher yields are due to:

1. low use fertilizer, primarily N
2. saline (alkaline?) soils in some areas for which no adaptive varieties are used.
3. low plant population as farmers plant one seedling per hill at wide spacing
4. lack of more adapted, improved varieties, especially for the cool season and under low fertilizer input
5. poor control of rice borers and Sarocladium

There is great potential for increasing rice in the southwest as represented by Samangoky.

In the replicated yield trials planted in 1985-86 season, 14 of the 26 named IR varieties produced between 5.3 to 6.6 t/ha (Table 21). Thus, the potential for identifying varieties higher yielding than recommended varieties is tremendous (Table 22 and 23). Salinity tolerant varieties are being tested in saline areas (Table 24).

The 228 varieties multiplied at Samangoky after release from quarantine are being tested at different locations as given in Table 12.

Increasing yields through improving plant population and cultural practices appears feasible. It also may be very favorable feasible to use legume crops for increasing soil nitrogen content.

NORTHWEST (REGION OF MAROVOAY, PROVINCED OF MAJUNGA)

There are approximately 191,000 ha of rice in Majunga. Within the province is a vast delta plain at Marovoay which cultivates 20,000 ha and is Madagascar's second rice bowl. FOFIFA has a rice research facility at Marovoay.

About 1500 mm of rain is received, primarily during the 6-month rainy season November through April. However, 10,000 ha of rice in the Marovoay basin are not grown to rice during this period because of deepwater ranging up to 2.0 m. In this basin rice is cultivated during the dry season and irrigated with water from several large reservoirs. Only one rice crop per year is grown.

The soils are characterized by fairly good fertility, however, it is estimated that 10-25% of the soils are affected by salt which encroaches during the end of the dry season. Annual inundation carries silt which maintains soil fertility.

Traditional varieties such as Alicombo and Boina 1525 are grown. IR20 is also grown to a limited extent, primarily on the more fertile soils. Rice yields in Marovoay average 2.5 t/ha.

Several factors are restricting yield increases:

1) limited-availability of fertilizers
2) use of long duration, unimproved varieties
3) lack of adapted varieties and of management techniques for saline soils
4) poor control of African white borer and pink borer (*Sesamia calamistis*)
5) poor control of weeds

The opportunities to increase production are excellent. There is the possibilities of increasing production by identifying deepwater areas during the rainy season. It should be fairly easy to identify higher yielding, better adapted varieties for both saline and non-saline areas.

Opportunities can be increased if fertilizers become available. Some of the tested varieties from IRRI introduction are described in Table 25, 26 and 27 in 1985-86 season. The yields are not very high indicating poor management and water controlling practices.

MIDDLE WEST, (MOYEN WEST)

To the west of the High Plateau lies a large area of potentiality cultivable upland and wetland ricelands. The Kianjasoa region is a transmigration area and is included in the national government priorities for developing rice cultivation. This region is characterized by a succession of plateaux separated by terraced paddies and bottomlands.

The annual rainfall averages 1600 mm. The rainy season commences in October and terminates in April. January has the highest rainfall amount 280 mm.

Kianjasoa is located at an altitude of 900 m. The annual average temperature is 18.9°C.

Mean farm size is 2.83 of which 1.0 ha is wetland and 1.83 ha is upland. Upland rice cultivation has a high potentialities for mechanized cultivation because of low population density weeds and Heteronychus spp.(root eating insect) are need to be controlled for upland rice cultivation. Some varieties showed tolerance to this insects as mentioned in Table 28. The result of varietal trial at farmer's field indicate great possibilities with IRRI introduced varieties (Table 29).

Studies on use of animal manure, organic manure and combination of NPK result shows that 5 t/ha animal manure with 45,30,30 NPK kg/ha gives significantly higher yield (Table 30).

Studies on date of planting and method of land preparation indicated that last week of September with traditional ploughing before seeding gives significant yield (Table 31).

EAST COAST (IVOLOINA)

The east coast rice production area lies between sea level and 900 m. The average total rainfall days are 241, and a total annual rainfall of 3526 mm. A good system of drainage is needed. Cyclones often cause damage to the rice crops.

Average annual temperature is 20°C and rice can be produce year-round. In fact, where drainage permits, two rice crops are grown. Average farm size is less than 2 ha.

Slash and burn rice cultivation (Tavy Vary) is also widely practiced on the upland, much to the detriment of rice environment, loss of forest and thus heavy erosion in the east coast region.

At present Ivoloina station is being used for multiplication of introduced lines and also testing disease and insect of eastern wet environment.

OTHER ACTIVITIES

1. Providing French edition of IRRI books to bookstores (bring examples of books to the rice meeting).
2. Translation of rice books into Malagasy
   - SAFAFI translating Rice Primer

- Rice Breeder translating Field Problems of Rice.

3. Providing information to MPARA about IRRI training courses (limited interest).
4. Cooperation research being conducted by DRD-DRA-IRRI economic department (for rice quality grain analysis)
5. Mechanization program - demonstration, working with manufacturer.

FUTURE PLANS

1) Continued recruiting and training of new scientists to increase research capabilities in Marovoay, Lac Alaotra and Samangoky.
2) Continued introduction of improved germplasm and its evaluation in the different environments.
3) Continued efforts to conduct on-farm research in selective locations and within a cropping systems framework.
4) Continued close contact with IRRI for providing expertise in critical areas and in providing germplasm, both rice and non-rice.
5) Continued infrastructure and manpower development at Mahitsy so as it could be national rice research institute for future development.

FINANCIAL REPORT

1) The project was under operation allmost two years instead of 2 1/2 years as out lined originally. The progress and status of budget is out lined in Table 32. It is clear from table that except in technical assistance and other direct and indirect costs, and contengency there wont be much money left. In fact, mutual undertanding with AID and IRRI, budget in commodities item is over spended. Ordering and shipment etc. takes long time.
2) Timely release of PL-480 money is still a problem to be solved. However, the office cum-lab building construction at Mahitsy is progressing well.

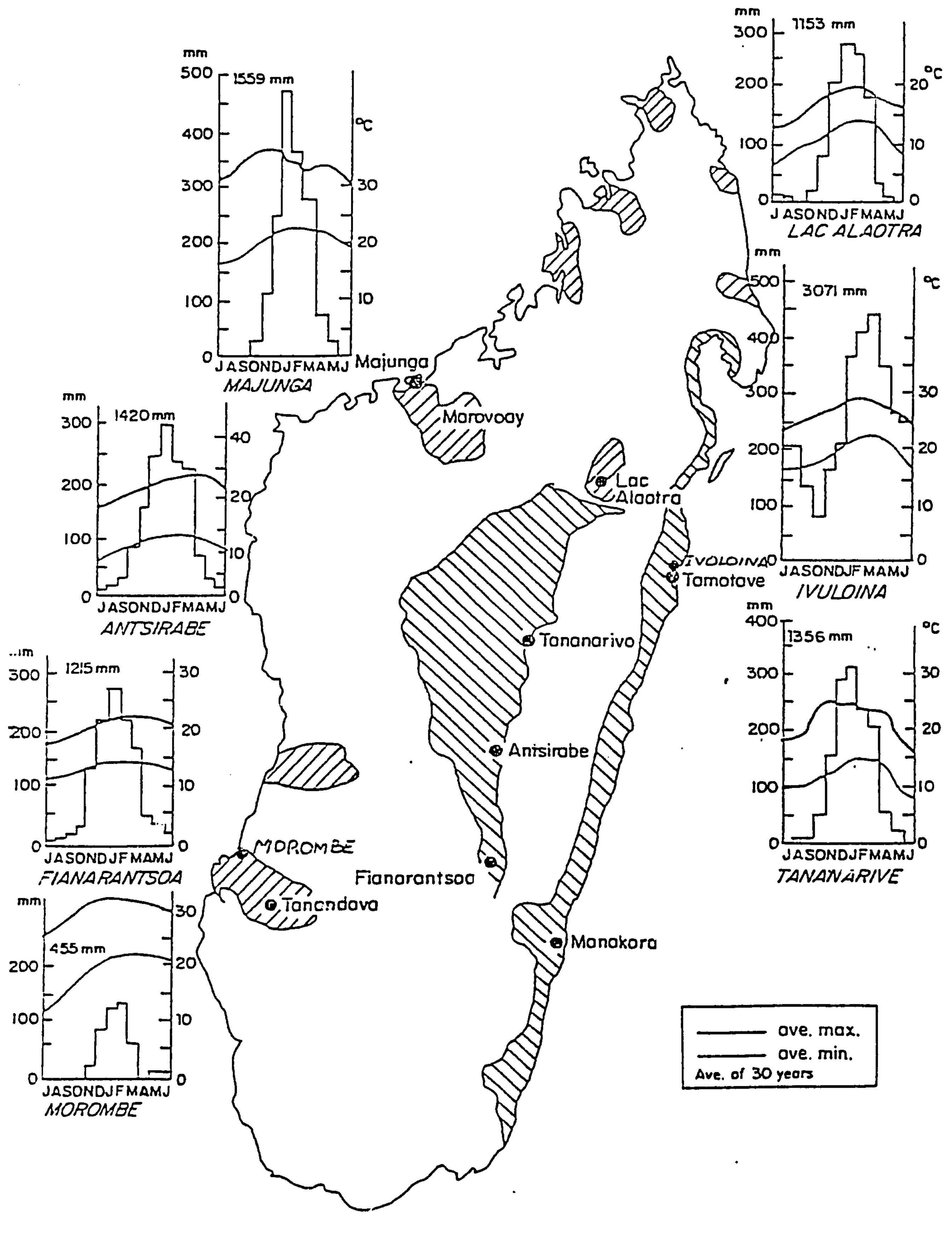

Fig. 1 Rainfall distribution and temperature range of several major rice-producing areas of Madagascar.

Table 1. TOTAL AVAILABILITY OF RICE (PRODUCTION, IMPORTATION AND CONSUMPTION)

MADAGASCAR, 1986-1985

Year	Population	Area	Yield per ha.	Paddy Prodn	Rice equiv.	Rice prod/pers	Imports (Net)	Rice availabilit Total	/ person.
	(000)	(000 ha)	(Tonnes per ha)	(000 tonnes)		(kg)	(000 tonnes)		(kg)
1966	6089	883	1,82	1603	917	151	- 6	911	150
1967	6241	901	1,89	1706	960	154	- 36	924	148
1968	6397	913	2,05	1873	1054	165	- 64	990	155
1969	6557	913	2,04	1858	1046	160	- 9	1037	158
1970	6721	935	1,99	1865	1050	156	- 48	1002	149
1971	6889	943	1,99	1873	1054	153	26	1028	149
1972	7061	1008	1,67	1687	949	134	23	972	138
1973	7237	1055	1,64	1730	974	135	90	1064	147
1974	7418	1134	1,63	1844	1038	140	122	1160	156
1975	7604	1078	1,83	1972	1110	146	60	1170	154
1976	7817	1064	1,92	1043	1150	147	67	1217	156
1977	8036	1175	1,76	1067	1163	145	93	1256	156
1978	8261	1133	1,70	1922	1082	131	152	1234	149
1979	8492	1158	1,77	2045	1151	136	155	1306	154
1980	8730	1178	1,79	2109	1187	136	175	1362	156
1981	8974	1186	1,70	2012	1132	126	192	1324	148
1982	9225	1188	1,66	1970	1109	120	351	1460	158
1983	9484	1189	1,81	2147	1208	127	175	1383	146
1984	9749	1163	1,82	2112	1189	122	112	1301	133
1985	10022	1180	1,84	2177	1225	122	104	1329	133

Source: Repoblika Demokratika Malagasy
Ministère des Transports, du Ravitaillement et du Tourisme
Etude de la Sécurité Alimentaire (prepared by Ross Bull, Graham Shuttleworth and Peter Hodgkinson for World Bank Project - April, 1986.)

TABLE 2 . FOFIFA PARTICIPATION IN RICE CONFERENCES AND WORKSHOPS.

DATE	PARTICIPANT	EVENT
June 5-8, 1985	Hon. Minister Antoine Zafera Rabesa, Minister of Science & Technology for Development	Symposium on Rice Research: Accomplishments and Challenges, IRRI
July 1984	Dr. Charles Razafindrakoto, Director General, FOFIFA	Individual consultation with IRRI administration and scientists
June 1-5, 1985	" "	International Rice Research Conference
June 5-8, 1985	" "	Symposium on Rice Research: Accomplishments and Challenges, IRRI
June 10-14, 1985	" "	International Rice Commissio Meeting, FAO held at IRRI
Oct. 15-20, 1985	Dr. Ravohitrarivo Clet Pascal Director of Research, FOFIFA	Rainfed Rice Research Conference, Bhubaneswar, India
March 4-8, 1985	" "	Upland Rice Research Conference, Jakarta, Indonesia
Jan. 7-10, 1985	Mme Rakotomanga Jeanine Rice Breeder	International Rice Program (Africa), IITA, Nigeria
Sept. 16-18, 1985	Mr. Rasolo Francois Chief, Dept. of Research and Development, FOFIFA	Farming Systems Socio-Economic Research, IRRI
	Mr. Randrianasolo Henri Upland rice agronomist, FOFIFA	" "
June 1-5, 1985	Mr. Rabary Eugene Rice Breeder	International Rice Research Conference
	Mr. Rakotonirainy Roland Head, Rice Breeding	" "
	Mr. Rabeson Raymond Head, Pedology Division	" "
November 1985	Mme Rakotoarisoa Jacqueline Cropping Systems Coordinator and Head of Agronomy Program	Asian Farming Systems Workshop, Dacca, Bangladesh
March 1986	Mme Rabenatoandro Yvonne Head, Department of Agronomy	Seed Health Unit, IRRI
	Mr. Rakotobe Rabehevitra Head, Service Protection Vegetale	
	Mme Randriamahazomanana Marie Albine Head, Quarantine Service	

	Dr. Ravohitrarivo Clet Pascal Director Scientific and Rice Coordinator	IRTP Monitoring Tanzania
	Mr. Rakotonomenjanahary R. Xavier Rice Breeder	" "
April 1986	Mme Rakotomanga Jeanine Rice Breeder	Rice Ratoon Workshop, Bangalore, India

TABLE 3 . FOFIFA PARTICIPANTS IN IRRI SHORT-TERM T[illegible]NING PROGRAMS.

Program	Participant	Duration
Genetic Evaluation and Utilization (GEU)	Rakotonirainy Roland	Feb. 4-May 24, 1985
	Rabary Eugene	" "
	Razanadraina Bienvenue	Feb. 3-May 23, 1986
	Rasoafalimanana Mbolarinosy	" "
INSFFER	Rabeson Raymond	Feb. 4-May 24, 1985
	Andrianaivo Bruno	Feb. 3-May 23, 1986
	Razafinjara Lala	" "
Cropping Systems	Rakotoarisoa Jacqueline	Feb. 4-June 28, 1985
	Rabarimandimby Berojo	Feb. 3-June 27, 1986
Basic Rice Production	Razafintsalama Lala	July 22-Oct.31, 1985
	Rajaonarison J.B.	" "
Integrated Pest Management	Randriamananoro J.J.	July 22-Nov. 9, 1985
	Andriatsimialona Dodelys	July 21-Nov.19, 1986
	Rakotovoalavo David G.	July 21-Nov.19, 1986
Special Plant Physiology	Rasolofo Pierre	Feb. 3-June 26, 1986
Agriculture Enginnering Course	Zafera Antoine	April 28-June 13,1986

TABLE 4. IMPORTS OF CHEMICAL FERTILIZERS IN MADAGASCAR IN PAST EIGHT YEARS (1978-84).

	N_2	P_2O_5	K_2O	compound	Total (Tons)
1985	-	-	-	-	13,500
1984	6,440	3,426	3,806	4,361	18,033
1983	2,583	1,645	8,123	6,765	19,116
1982	6,191	2,336	2,428	14,009	24,964
1981	1,046	2,846	2,820	3,844	10,556
1980	9,126	1,469	1,269	7,546	19,410
1979	6,212	585	3,193	5,074	15,064
1978	8,623	3,548	3,864	5,232	21,267

TABLE 5. THE YIELD OF ROJOFOTSY RICE AS AFFECTED BY TIME OF APPLYING 30 KG N/HA. MAHITSY: 1985 WET SEASON.

Rate	Time and rate of N BASAL	30 DAT	PI	Yield (t/ha)	
30-60-60	1	30 1/		3.5	a
30-60-60	15		15	3.2	ab
30-60-60			30	3.0	b
30-60-60	30			2.8	bc
0-60-60				2.4	cd
0-0-0				2.2	d

1/ applied cn dry soil before rains

TABLE 6 . METHOD OF APPLICATION AND DOSE OF P_2O_5 IN FARMERS' FIELD IN MANJAKANDRIANA 1985-86.

S.No.	TREATMENT KG/HA N - P - K ZnSO4	YIELD KG/HA
1	0 - 0 - 0 - 0	2533 c
2	60 - 0 - 60 - 5	3700 b
3	60 - 30 - 60 - 5, P_2O_5 Broadcast	3900 ba
4	60 - 30 - 60 - 5, P_2O_5 dipping root	4250 a
5	60 - 60 - 60 - 5, P_2O_5 Broadcast	4450 a

- The results are significantly different and most economical dose seems to be treatment 4.
- The soil is hydromorph with mineral on the surface and silty peat in the subsoil.

TABLE 7 . RESPONSE OF N,P,K, Zn AND SULPHUR ON THE FARMERS' FIELD IN TWO LOCATIONS 1985 - 86.

S.No.	TREATMENTS kg/ha N - P - K - Zn - S	YIELD KG / HA MANJAKANDRIANA 1	2	ANDAKANA (SUD) 3
1	0 - 0 - 0 - 0 - 0	2300 a	2900	3222
2	60 - 60 - 60 - 8 - 15	3885 b	5500	4407
3	0 - 60 - 60 - 8 - 15	2800 a	4000	4778
4	60 - 0 - 60 - 8 - 15	2450 a	3900	3324
5	60 - 60 - 0 - 8 - 15	3765 b	5200	5028
6	60 - 60 - 60 - 0 - 15	3865 b	5100	3852
7	60 - 60 - 60 - 8 - 0	3950 b	4300	—

- 1=Result at this site is significantly different as shown in the Table . Respons of P_2O_5 is clear. More or less good response of Nitrogen and no response of Potassium. The response of Zinc and Sulphur is not significant.

- 3=Result at this site shows response of N,P,K and Zn and also N-response is well with P.

TABLE 8 . EVALUATION OF ORGANIC AND BIOLOGIC MANURE IN COLLABORATION WITH CHEMICAL FERTILIZERS IN MANJANKANDRIANA AND MAHITSY REGION ON THE FARMERS' FIELD 1985-86.

S.No.	TREATMENTS in kg/ha	AVERAGE YIELD KG/HA MANJAKANDRIANA	MAHITSY
	N P K and other source		
1	0 - 0 - 0	989 c	2005 c
2	0 - 0 - 0 + 5000 A.manure	1536 bc	3005 a
3	60 -90 - 0 + 5000 "	2288 a	3551 a
4	60 -90 -60	2204 a	3092 a
5	53 -90 -53 + 250 E.O.B.	1854 b	3501 a
6	45 -90 -45 + 500 E.O.B.	2158 a	3309 a
7	70 -90 -30 + 1000E.O.B.	2371 a	2983 ab
8	0 - 0 - 0 + 250 E.O.B.	1002 c	2340 bc
9	0 - 0 - 0 + 500 E.O.B.	1436 bc	2565 b
10	0 - 0 - 0 + 1000E.O.B.	1303 bc	2298 c
11	0 - 0 - 0 + 2000E.O.B.	1119 bc	2164 c

- The results are significantly different in Manjakandriana and treatment 6 seems to be most economical from one year's testing. These experiments will be repeated two more seasons. The average yield of this region is less than 800 kg rice per hectare.
- The soil is hydromorphic mineralized type with low pH and relatively cold temperature prevails during growing period and suspectible to iron toxicity.
- The results are also significantly different in Mahitsy region where the soil is hydromorphic with high humus content. For obtaining economic return mineral fertilizer is needed to mixe with organic manure.
- Treatment 4,5 and 6 in Mahitsy uses on 60 kg P_2O_5.

TABLE 9 . RESPONSE OF ROJOFOTSY RICE TO N AND AZOLLA. 1985 WET SEASON MAHITSY.

Fertilizer	Yield (t/ha)	
60-60-60	4.7	a
30-60-60	4.0	a
30-60-60 + Azolla	3.4	ab
0-60-60 + Azolla	3.4	ab
0-60-60	3.1	ab
0-0-0	3.0	b

TABLE 10 . STUDIES ON AZOLLA UTILIZATION WITH DIFFERENT DOSE OF NITROGEN IN BETAFO (ANTSIRABE) 1985-86.

S.No.	TREATMENT	YIELD KG/HA	
	Kg/ha Nitrogen	With Azolla	Without Azolla
1	0	3757 b	3268 b
2	30	4055 b	4264 b
3	60	4104 b	3515 b
4	90	5694 a	3771 b

- The result with Azolla and 90 kg N is significantly different than other dose of N. However, without azolla the results are not significantly different.

- In a country difficient in chemical fertilizer, supply of azolla can be a natural source of organic manure specially Phosphorous rich soil of Betafo area.

TABLE 11 . COMPARISON OF SUPPER GRANULE (SG) AND UREA AS A SOURCE OF NITROGEN AT DIFFERENT LOCATIONS ON FARMERS FIELD 1985-86.

S.No.	TREATMENT	YIELD KG/HA				
		ITOASY	KIANJASOA	MANJAKANDRIANA	BELANITRA	
	N - P - K KG/HA	1	3	3	1	2
1	27 - 60 - 60 (urea)	3019	4125	2406	4713	4203
2	54 - 60 - 60 (urea)	3462	3792	2751	4386	4751
3	81 - 60 - 60 (urea)	3643	-	-	4057	5885
4	0 - 60 - 60	1670	3792?	2122	2621	3675
5	27 - 60 - 60 (S.G.)	2697	3583	2741	3070	4605
6	54 - 60 - 60 (S.G.)	3523	4083	3108	3194	5154
7	81 - 60 - 60 (S.G.)	3281	-	-	4199	4971

- 1 = variety Rojofotsy, 2 = variety Chianan-8, 3 local varieties used in Vakiambiaty season. The data are difficult to summarize at this stage. These need to be corelated with soil analyses studies.

TABLE 12.228 NEW INTRODUCED VARIETIES THROUGH INTERNATIONAL GERMPLASM CENTER AND IRTP, IRRI ARE BEING TESTED IN ROD ROW AND REPLICATED TRIALS IN THE FOLLOWING AGRICULTURE STATIONS. 1985/86.

Name of trial	Station
1. Initial Evaluation trial-7 var.	Belanitra
2. Two dates of planting 13 elite lines	Mahitsy
3. Two dates of planting IRCTN-144 var.	Mahitsy
4. Rod rows of upland varieties-16	Kianjasoa (moyen west)
5. Initial Evaluation Trial of 25 IRRI released varieties.	Samangoky
6. Initial Evaluation trial of early 40 varieties	Samangoky
7. Initial Evaluation trial rainfed lowland 11 varieties	Samangoky -"-
8. Initial Evaluation salt tolerance 5 varieties	-"-
9. Initial Evaluation Rainfed lowland trial 25 varieties	Marovoay
10. Initial Evaluation trial Deepwater 4 varieties	Marovoay
11. Rod row trial for cold tolerance 13 lines	Antsirabe
12. Seed multiplication of new release from Quarantine	Ivoloina, Tamatave
13. Upland rice trial 15 varieties	Ivoloina, Tamatave
14. IRRI materials 228 screening for disease	Ivoloina
15. high altitude cold tolerance test 26 varieties	Vinaninony
16. Early maturing rainfed low land trial 38 varieties	Fianarantsoa
17. Early maturing and elite lines 26 varieties and lines	Lac Alaotra
18. International rice yield nursery very early - 29 varieties	Lac Alaotra
19. stemborer tolerance-36 varieties	Lac Alaotra
20. Rainfed lowland varieties-25	Lac Alaotra
21. Upland varieties test-16	Lac Alaotra

TABLE 13 . COMPONENT TECHNOLOGY TRIAL AT MANJAKANDRIANA WITH TWO LEVEL OF FERTILIZER AND SEVEN VARIETIES TESTED IN THE FARMERS FIELD 1985-86.

S.No.	VARIETY	YIELD KG/HA			
		F1= N P K 0 0 0		F2 = N P K Zn 45-45-45 - 8 kg/	
		1	2	1	2
1	Local variety	1283	1280	1858	1583
2	Rojofotsy (2821)	1275	1300	1800	1633
3	Tainung-3	983	1183	1533	2283
4	Chainan-8	833	1567	1283	2467
5	Rojomena (2822)	1600	1500	2033	1917
6	IRAM-10	1467	1600	2275	2116
7	Rojofotsy 1285	733	1200	1258	1661

- 1 = soil mineral , 2 = soil organic.
- F1= zero fertilizer use, F2 = 45,45,45,8 NPK Zn kg/ha
- variety 1 and 2 are stable in performance, variety 3 and 4 need high level of management, variety 5 and 6 may give high performance and variety 7 has limited performance.

TABLE 14 . OTHER ROD ROW TRIALS CONDUCTED AT MAHITSY IN 1985-86.

1. 19 Elite lines and varieties tested, six were selected depending on yield, disease and maturity. The yield ranged from 4 to 5.5 T/ha.

2. 148 varieties and lines tested for cold tolerance in Mahitsy station under October and January showing helped in selecting 49 entries for high plateau up to 1270 m and 47 entries suitable for 1500 m to 1900 m. Some of the important characters are mentioned below.

   a) These entries have early maturity (120-140 days), medium maturity (140-160 days) and late maturity group(160 to 180 days)

   b) These entries are resistant to disease and pest under natural condition of rod row screening.

   c) Early maturing entries also have ratooning ability which is very important in some areas of high plateau where farmers use ratoon for animal feed. But with these varieties they can harvest rice and straw for cattle. Most of high plateau varieties are late maturing (160 to 180 days) so can not be used for grain yield.

3. In Antsirabe out of 10 IRRI-introduction, line IR-19743-46-2-2-3-2 and IR 19746-10-1-3-3-2 were selected for maturity and disease tolerance.

TABLE 15. PRELIMINARY TRIAL (VARIETAL B) AT MAHITSY STATION (1270 m), 1985.

S.N.	Acc.N.	VARIETY	YIELD kg/ha	MATURITY days	YIELD kg/day
1	3190	IR-38	4525	175	25.8
2	3188	IR-36 b	4145	175	23.7
3	1285	Rojofotsy (control)	4055	175	23.1
4	3187	IR-36 a	3925	160	24.5
5	3334	77028-ZhenBui N.134	3790	165	22.9
6	3327	77014-Tonkan N.1	3665	160	22.9
7	1632	Chainan-8 (control)	3500	155	22.5
8	2731	Madirat 185	3030	175	17.3
9	2741	Madirat 195	2275	175	13.0
10	2720	Madirat 74	2165	145	14.9

Average yield 3507

C.V. 10.1%

Fertilization 60-60-60 N-P-K kg/ha.

TABLE 16. PRELIMINARY RICE VARIETAL TRIAL (VARIETAL B) AT MAHITSY STATION (1270 m) 1986.

S.N.	Acc. No.	VARIETY	YIELD KG/HA
1	2509	1632/1300	6747
2	2787	B54/b/km/112/2/2	6253
3	3187	IR-36-b	5647
4	2792	Ratva-D	5620
5	1632	Chainan-8	5507
6	1285	Rojofotsy	5247
7	3327	Tong KanNol	5120
8	3190	IR-38	5073
9	3188	IR-366	4927
10	334	Zhen Bui No 134	4063

The results are significant at 1% level. Fertilizer used 87-64-60, NPK kg/ha.

TABLE 17. INITIAL EVALUATION TRIAL CONDUCTED AT FIANARANTSOA FOR 40 VARIETIES AND LINES IN 1985-86. RESULTS OF 12 PROMISSING ENTRIES ARE REPORTED BELOW WHICH FALL IN MEDIUM MATURITY GROUP WILL BE TESTED IN VARIETAL TRIAL IN 1986-87.

S.No.	VARIETY	Yield kg/ha	Yield kg/day	MATURITY in days
1	K440-429-1-2	7450	46.5	160
2	SWAT-2	7063	45.5	155
3	Bir-Ze Coo	6525	42.0	155
4	B2982b-SR-62-3-1-4	6450	39.1	165
5	IR 25670-15-2-3	6288	39.3	160
6	ADT-36	6188	41.2	150
7	IR-19746-10-1-3-3-2	6075	40.5	150
8	IR 15579-135-3	5875	35.6	165
9	Palchard-31-1-3	5800	38.6	150
10	IR-1972-86-3-2-2-3	5775	38.5	150
11	IR 20107-120-6	5630	38.8	145
12	IR 22107-113-3-3	5613	35.0	160
13	Chainan-8 (Check)	5510	34.4	160
14	Angika (Local Check)	5420	31.8	170

Fertilizer application 90,60,60 NPK kg/ha N2 in two split application.

TABLE 18 . SOME OF THE INTERESTING VARIETIES FROM IRRI ROD ROW SELECTION IN LAC ALAOTRA STATION FOR 1986-87.

S.No	VARIETY	YIELD KG/HA	MATURITY IN DAY
1	IR-40	3150	139
2	IR-971-7-1-5-1	3195	120
3	BR-51-3-15-4	3100	140
4	32 Xuan5-C	3962	120
5	BR-11	3325	139
6	IR 13146-45-2	3450	129

Fertilizer used 45-45-45 NPK kg/ha

TABLE 19 . VARIETAL TRIAL OF 9 ENTRIES IN TWO DATES OF PLANTING IN LAC ALAOTRA STATION 1985-86

S.No.	VARIETY	YIELD KG/HA		TOTAL	MATURITY IN DAYS	
		D_1	D_2	kgS	D_1	D_2
1	Tche Kouai	3520	4580	8100	155	160
2	IR-36	3180	3080	6260	140	158
3	Makalioka-34 (Local Check)	4180	1860	6040	180	172
4	B541-kkm-112-2-2	2680	2900	5580	142	170
5	IR532-1-171	2530	2533	5040	143	165
6	Zhen Bai 134	2100	2370	4470	145	150
7	TongKan No1	1600	2380	3980	145	152
8	HuNon Haien	1160	2080	3240	133	155
9	Chianan-8	810	2280	3090	133	155

- D1 = Transplanted 30 days old seedling on 12.12.85
- D2 = " 36 days old " on 19.01.85
- Fertilizer application was 60,60,40 kg NPK/ha

TABLE 20. SOME OF THE VERY EARLY SELECTED VARIETIES AND LINES IN LAC ALAOTRA STATION UNDER TWO DATE OF PLANTING OUT OF 28 ENTRIES WHICH WERE FREE FROM DISEASE AND INSECTS IN 1985-86 SEASON.

S.No.	VARIETY	YIELD KG/HA		MATURITY IN DAYS	
		D1	D2	D1	D2
1	ADT-36	1890	2840	132	130
2	AS 10789	2670	2960	140	140
3	BG 367-4	1640	2720	135	133
4	IR-19785-52-3-2-1	1180	2820	130	133
5	IR-5890-B2-5-3	1940	2740	140	133
6	Palchar 31-1-3	2240	3000	132	131
7	UPR-231-28-1-7-TCA	2090	2790	131	130
8	IR-50	1640	3090	131	131

- D1 = Transplanted 30 days old seedling on 13.12.85
- D2 = Transplanted 42 days old seedling on 25.1.85
- Fertilizer dose used 45,45,45 kg NPK/ha
- All together 151 varieties and lines were tested in rod row trial. The rainfall was not good during transplanting time and not much water at the station during drought so these lines will be retested in 1986-87 again.

TABLE 21 . TESTING OF 25 VARIETIES IN A VARIETAL TRIAL FOR IRRIGATED CONDITION IN TANANDAVA (SAMANGOKY STATION) 1985-86.

S.No.	VARIETIES	YIELD KG/HA	MATURITY IN DAYS
1	IR-50	6694	114
2	IR-36	6652	114
3	IR-56	6480	116
4	IR-60	6473	124
5	IR-45	6305	131
6	IR-52	6295	124
7	IR-26	6151	131
8	IR-54	6102	132
9	IR-38	5790	136
10	IR-46	5524	131
11	IR-28	5506	110
12	IR-40	5496	126
13	IR-34	5408	130
14	IR-42	5334	135
15	IR-8 (Check)	4615	28

- CV = 20.02% varieties do not differ significantly at 5% level from serial No.1to 14.
- Fertilizer use 46 kg/ha N2 only
- Only the yield of 14 most promissing varieties are reported here.

TABLE 22 . TESTING OF 40 VARIETIES IN REPLICATED TRIAL FOR RAINFED LOWLAND CONDITION IN SAMANGOKY STATION 1985-86.

S.No.	VARIETY	YIELD KG/HA
1	IR-19728-6-3-2-2-3	7316
2	AS-688	6795
3	IR 19743-46-2-3-3-2	6714
4	IR 197446-10-1-3-3-2	6535
5	IR 25924-51-1-3	6392
6	IR 19735-5-2-3-2-1	6242
7	IR 25924-92-1-3	6068
8	IR 25588-7-3-1	6067
9	UPR 103-80-1-2	6059
10	IR 28128-45-2	6056
11	IR 10107-12-6	5997
12	ADT-36	5926
13	UPR 231-28-1-2	5890
14	RTN 122-4-1-3	5876
15	Malika	5508
16	AS 19789	5384
17	IR 19728-9-3-2-33	5274
18	UPR-231-26-1-7-KAZ	5273
19	IR-58	5126
20	Tsipala (Local Check)	4670

- C.V. = 10.2% the varieties are highly significant at 5%. There is no significant difference in first 10 varieties.
- Only results of 20 varieties are reported here which are selected for next years' test depending on most of varieties mature in 100 to 120 days.

TABLE 23 . VARIETAL TRIAL OF 25 ENTRIES IN LATE MATURITY GROUP FOR RAINFED LOWLAND CONDITION IN SAMANGOKY 1985-86.

S.No.	VARIETY	YIELD KG/HA
1	IR-8608-82-1-3-1-3	5778
2	IR-13260-100-IE-P^{2}	5523
3	IR-13564-95-1	4974
4	IR-5853-198-1-2	4934
5	IR-4744-295-2-3	4740
6	IR-14753-86-2	4706
7	Mahsuri	4387
8	IR-19083-22-2-2	4277
9	BR-11	3408
10	Rokoroko(Local check)	4384

- C.V.= 27.3%.Highly significant at 5%
- Fertilizer application 46 kg N at basal
- Only 10 best varieties were selected for 1986-87 season

TABLE 24 . VARIETAL TEST FOR SALINITY TOLERANCE CONDUCTED IN SAMANGOKY 1985-86.

S.No.	VARIETY	YIELD KG/HA
1	IR-11-418-19-2-3	4520
2	IR 10198-66-2	3740
3	IR 9884-54-3	3420
4	Sary Tsipala(Local check)	3330
5	IR 9764-45-22	2750

- C.V.= 27.2%. The varieties are not significant because of high irriation frequency.
- The trial will be repeated again in ideal condition in 1986-87.

TABLE 25. UPLAND RICE VARIETAL TRIAL CONDUCTED IN MAROVOAY STATION IN ASARA SEASON 1985-86.

S.No	VARIETIES	Yield T/ha	Flowering days	Plant height cm.
1	NDR-80	2.8	83	80
2	IR 9729-67-3	2.5	69	83
3	IRAT 134	2.3	76	83
4	IRAT 142	2.3	67	80
5	IRAT 112	2.1	76	91
6	CR155-5029-12	1.8	76	91
7	ADT-36	1.6	78	87
8	IAC 25/64 (Check)	1.4	62	115

Fertilizer used 68-45=45 NPK Kg/ha.

TABLE 26. IRRIGATED RICE VARIETAL TRIAL CONDUCTED IN MAROVOAY STATION IN JEBY 1985.

S. No	VARIETIES	Yield kg/ha	
1	IR-38	2631	a
2	IR-36b	2262	a
3	IR-32	2225	a
4	Boina (Check)	1725	
5	IR 36a	1681	
6	Ali-Combo (Check)	906	

CV = 23.45%, the results are significant at 5% level.

Fertilizer used only 46 kg N_2/ha.

TABLE 27 . NEW INTRODUCTION OF RICE LOWLAND RAINFED FOR ASARA SEASON IN AMBOROMALANDY (MAROVOAY) 1985-86.

IRRI-Number	VARIETIES	Yield T/ha
307	BR-11	1.45
308	BR-4	2.20
309	BR-51-74-6-J1	1.80
310	Cisadane	2.37
311	IR 10781-143-2-3	1.94
313	IR 13257-46-1EP$_2$	1.81
314	IR 13260-100-IE-P$_2$	2.43
315	IR 13358-16-3-2	2.72
316	IR 13564-95-1	2.83
317	IR 14753-86-2	1.93
319	IR 19083-22-2-2	2.39
320	IR 19256-88-1	1.96
321	IR 19431-72-2	2.13
322	IR 3179-25-3-4	2.62
323	IR-46	2.05
324	IR 4744-295-2-3	1.58
325	IR 4819-77-3-2	1.80
326	IR 4829-89-2	3.20
327	IR 5873-9-1	3.73
328	IR 5873-9-1	2.53
329	IR 8606-82-1-3-1-3	2.20
332	RP 1045-25-2-1	2.04
333	Mahsuri	1.46
	local check	1.45

9 highest yielding varieties are selected for next seasons' trial, under farmers' management.

TABLE 28. EVALUATION OF 16 IRRI INTRODUCTION IN ROD ROW TRIAL IN KIANJASOA 1985-86. MENTIONED HERE ARE ONLY SELECTED ENTRIES FOR 1986-87 TRIAL.

S.No.	VARIETY	MATURITY IN DAYS
1	IRAT-112	115
2	IR 9729-67-3	120
3	IRAT 142	120
4	Narendra-1	120
5	NDR-80	150
6	NDR-102	125
7	OR 164-5	120
8	IRAT-134	132

The yield of these entries is higher than check IAC 25/64 and these were free from <u>Heteronychus</u> spp. (serious root eating insect in upland).

TABLE 29. IDENTIFICATION OF VARIETIES FOR INTENSIVE CULTIVATION IN LOWLAND IRRIGATED TRIAL AT FARMERS' FIELD IN KIANJASOA BY AGRONOMY DIVISION 1985-86.

S.no.	VARIETIES	YIELD kg/ha	FLOWERING IN DAYS FROM TRANSPLANTING
1	IR-38	6801	93
2	IR-36-b	5959	93
3	IR 36-a	4595	93
4	Chainan-8 (Check)	4656	123
5	B 54-b-km-112-2-2	7842	116
6	Tsipala (Check)	4411	120

CV = 30.09% Results are not significant.

IRRI varieties look better for component technology as they are early in maturity.

TABLE 30 . STUDIES ON ORGANO-BILOGIC MANURE AND ANIMAL MANURE IN ASSOCIATION WITH CHEMICAL FERTILIZER FOR THE YIELD PERFORMANCE OF A UPLAND VARIETY IAC 25/64 (Acc. No. 2366) in KIANJASOA STATION 1985-86.

S.No.	TREATMENT kg/ha	YIELD KG/HA.
1	0-0-0 NPK	1868 a
2	5000 Animal Manure	1769 a
3	250 E.O.B.	1910 a
4	500 E.O.B.	2636 ab
5	750 E.O.B.	2306 ab
6	1000 E.O.B.	2979 bc
7	45-30-30 NPK	1708 a
8	45-30-30-5000 A.manure	3340 c
9	45-30-30-250 E.O.B.	2125 a
10	45-30-30-500 E.O.B.	2667 b
11	45-30-30-750 E.O.B.	2674 b
12	45-30-30-1000E.O.B.	2576 b

- E.O.B.- Engrais Organo Biologique
- The effect of E.O.B. over 500 kg/ha application with chemical fertilizer do not increase significantly.
- There is a distinct significant difference with animal manure and chemical fertilizer application as seen in treatment 8.

TABLE 31. STUDIES ON A UPLAND VARIETY FOFIFA 3401 FOR LAND PREPARATION AND SEEDING DATE AT KIANJASOA STATION 1985-86.

S.No.	TREATMENT: date of seeding	YIELD KG / HA Traditional Ploughing before seeding	Ploughing After harvest of previous crop.
1	Sept. 30	6168 c	5808
2	Oct. 10	5283 b	5375
3	Oct. 21	6083 c	6425
4	Oct. 31	4025 b	5625
5	Nov. 11	3741 ab	4292
6	Nov. 21	4999 a	3500

- The fertililizer used was 45-30-30 kg/ha NPK.
- The previous crop was groundnut on the same field.
- The results are significant in traditional plounghing before seeding where as the results are not significant in second land preparation plounghing after harvest of previous crop. In this case the fertility added by groundnut would have been lost during following fallow period.
- Land preparation just before seeding of upland rice seed with September sowing gives most significant yield. Seeding between September and October third week is recommendable.

TABLE 32.

THE INTERNATIONAL RICE RESEARCH INSTITUTE

IRRI/MALAGASY RICE RESEARCH PROJECT
FINANCIAL REPORT
FOR THE PERIOD MARCH 1, 1986 TO MAY 31, 1986

Grant Number : AID #936-4111*

Amount of Grant : $1,200,000.00

Date Submitted : July 21, 1986
Period covered by this report:
From : February 20, 1984
To : May 31, 1986

	EXPENDITURES: Previously Reported	EXPENDITURES: 2nd qtr. 3/ 01/ 86 5/ 31/ 86	EXPENDITURES: TOTAL	Estimated Expenditures Ending 8/ 31/ 86	Total Projected Expenditures	BUDGET	BALANCE
1. Technical Assistance	$361,460.80	$42,773.12	$404,233.92	$135,899.24	$ 540,133.16	$ 668,400.00	$128,266.84
2. Training	97,543.12	4,809.65	102,352.77	16,451.58	118,804.35	147,800.00	28,995.65
3. Commodities	180,605.88	30.493.91	211,099.79	83,383.36	294,483.15	150,000.00	(144,483.15)
4. Other Direct Costs, Indirect Costs, and Contingency	55,359.01	18,837.44	74,196.45	23,292.41	97,488.86	233,800.00	136,311.14
TOTAL	$694,968.81	$96,914.12	$791,882.93	$259,026.59	$1,050,909.52	$1,200,000.00	$149,090.48

Funds released to I.R.R.I.	$694,968.81
Less: Expenditures	(791,882.93)
Cash Balance (deficit)	($ 96,914.12)
Less: Estimated Expenditures	259,026.59
Estimated Balance (Deficit)	($355,940.71)

Certified Correct:

Paul A. Cooper
Director, Budget and Accounts

* A three-year (3) Grant, to develop an institutional mechanism for the exchange of information and materials between IRRI and the GDRM rice research institution.

ANNEXURE 3

PROGRESS REPORT

COOPERATION BETWEEN THE EGYPTIAN MINISTRY OF AGRICULTURE (MOA) AND IRRI

COOPERATION BETWEEN THE
EGYPTIAN MINISTRY OF AGRICULTURE (MOA) AND IRRI
REPORT, OCTOBER 1985 - FEBRUARY 1986

The existing arrangement whereby IRRI works with the Egyptian Ministry of Agriculture under a subcontract with the University of Davis, California, and financial support from USAID terminates on February 28. However the Egyptian Ministry of Agriculture appealed to us to continue to support the IRRI rice breeder working in Egypt, and we have agreed to do this until August, 1986. In November we were advised by USAID that they would be willing to support a proposal for continued collaboration between IRRI and the Ministry of Agriculture, and Dr. Ahmed Momtaz, Director General of the Agricultural Research Center of the Ministry of Agriculture, requested our support in the further development of the following:

(1) rice breeding objectives
(2) disease management and control
(3) seed production and handling
(4) rice crop agronomy
(5) training and technology transfer
(6) completion and development of the facilities at Sakha as the Egyptian National Rice Research Institute (ENRRI).

A proposal for collaboration between the Ministry of Agriculture and IRRI, financed by a grant from USAID, is currently being discussed between the parties involved. In the meantime USAID has been requested to provide a grant to IRRI from residual funds of the University of California project to enable the existing Egyptian staff of the Rice

Research and Training Project to be continued until the new project is initiated, and to provide funds to support Dr. E.A. Siddiq and the rice breeding program, and Dr. J.M. Swagerty, the seed specialist and leader of the program. It is anticipated that the interim grant will become available on March 1, 1986.

The weather conditions which lead to the outbreak of blast disease and seriously affected rice production iN 1984 were not repeated in 1985, and cultural methods taken to avoid recurrence of the disease, were successful, so that a good rice harvest was obtained. Nevertheless concern about the possible recurrence of the disease remains a major issue and various steps are being taken to strengthen the resistance breeding program. IR28 and other IR lines showed outstanding resistance to the Egyptian races of blast. This has increased interest in the IR lines, in spite of the difference in grain type to the existing japonica lines. The area planted to IR lines again increased considerably in 1985.

The IRRI engineer, Mr. Salvador Labro, completed his assignment and returned to IRRI in December. Over the 5 years of the project period we assigned successively, Charles Moss, Dr. M.M. Parker, and Mr. S. Labro to the position. The intention was to introduce and test IRRI small farm machinery to the region, test it for adaptation to local conditions, train Egyptian staff in its use and maintenance, and identify and collaborate with manufacturers in its fabrication. Only the introduction and testing of the machinery has proved possible. No counterpart engineer was identified, and manufacturers were not able to produce satisfactory machines. A major limitation was the fact that responsibility for agricultural machinery development in Egypt rests with another branch of the Ministry, so that our engineer remained isolated. The IRRI machines showed clear advantages in terms of adaptability and cost when compared with other larger machines currently under evaluation. We plan to continue collaboration through consultancies between IRRI and the Ministry and possible short-term assignments of IRRI engineers.

IRRI's participation through an extension liaison scientist in the Mabrouk-4 program (similar to Masagana 99) has been well received, and the program is generally regarded as a considerable success. Nevertheless, certain problems arose because extension is a responsibility of another branch of the Ministry, separated from research. It is therefore proposed that the role of the Sakha Rice Centre should include training of extension specialists, but that the extension program should be conducted independently. In line with IRRI's current policy of devolving training at the production level to the interested countries, and in agreement with Egyptian proposals, we plan to locate a scientist primarily responsible for training and technology transfer at Sakha, to develop training activities at Sakha. Initially, and under the USAID grant, this would be solely for Egypt. However, Minister Wally has expressed the view that Sakha should be developed as an "IRRI satellite" which could be used by other African countries for training. Training for the Sahelian member states of WARDA, namely Burkina Faso, Mali, Mauritania, Niger, and Senegal, would be more relevant at Sakha than n Nigeria, Liberia or Ivory Coast, where IITA and WARDA training programs are now conducted.

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ANNEXURE 4

PROGRESS REPORT

APPLICATION OF MONOCLONAL ANTIBODY TO RICE VIRUS EPIDEMIOLOGY IN THE TROPICS

qk'

Progress Report
From January 1 to June 30, 1986

APPLICATION OF MONOCLONAL ANTIBODY TO RICE VIRUS EPIDEMIOLOGY IN THE TROPICS

Grant Number : AID #492-5542-G-SS-4094-00

Principal Investigator: H. Hibino
International Rice Research Institute
P.O. Box 933
Manila, Philippines

-95

1. Purification of RTBV and RTSV from doubly infected plants:

RTBV and RTSV have been purified previously from plants singly infected by each virus. However, virus yields from singly infected plants were very low (OD_{260} 1.0 - 2.0 for RTSV; $OD_{260} < 1.0$ for RTBV). Attempts were made to purify both viruses from doubly infected plants which could be produced easily in large amounts in the greenhouse. By using a more simplified procedure (see attached) two viruses could be obtained from one purification. Moreover, virus yield (RTBV and RTSV, combined) was much higher $OD_{260} > 12.0$) in doubly infected plants. The virus mixture will be used to produce monoclonal antibodies to each virus.

2. Latex test using McAb to detect RGSV in plant tissue

ELISA and DIBA tests, efficiently detected RGSV antigen in infected plants. However, these methods were time consuming, expensive, complicated and can test few samples at a time. Latex test using McAb was applied to detect RGSV in infected plants. Using standard (latex test) procedures, RGSV antigen was detected in infected plant sap diluted up to 2,500 times. Ascitic fluid or partially purified IgG diluted 1000 times could be used to sensitize latex particles. Efficiency was comparable to ELISA but latex test is simple, cheap, less time consuming and can test more samples at a time.

3. Preparation of polyclonal antibody to rice ragged stunt virus

RRSV was purified from RRSV infected TN1 plants. Whole infected plants including roots were homogenized with 0.1 M phosphate buffer in 0.01 $MgCl_2$. Then the extract was filtered through cheese cloth. Virus was purified following the procedure (See attached). After the sucrose density gradient centrifugation, virus containing zone was collected. Purified virus fraction had 260/280 ratio of 1.3.

Five 1-ml aliquots of purified virus, of which A_{260} nm was adjusted to 1.0 were injected into two rabbits in 2 weeks interval. The first 4 injections were made intramascularly and the last injection was made intravenously. One week after the last injection, antisera were collected. The antisera had titer of 1:1280 in both ring-interface precipitin and agar gel diffusion tests.

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Procedure for RTBV/RTSV Purification (Simplified)

Fresh leaves with RTBV/RTSV (400 g)

Homogenized in 0.01 M EDTA (pH 8.5); filter through cheese cloth
Add 3 g Driselase, stir 1 hr (room temp.)
Heat at 40 C, 1 hr
10,000 rpm, 15 min

Supernatant

Add 7% PEG 6000, 0.2 M NaCl, 1% Triton X-100, stir 30 min
14,000 rpm, 30 min

Pellet

Suspend in 0.01 M EDTA (pH 8.5); stand overnight
Add 20% CCl_4, blend 3 min
10,000 rpm, 15 min

Supernatant

40,000 rpm, 60 min

Pellet

Suspend in 0.01 M EDTA; stand 1 hr
10,000 rpm, 10 min

Supernatant

Layered in 10-50% sucrose gradient in 0.01 phosphate buffer (pH 7.2)
25,000 rpm, 2.5 hr

Virus Zone (Collected)

Dilute with 0.01 M phosphate buffer (pH 7.2)
40,000 rpm, 60 min

Pellet

Suspend in buffer as above
10,000 rpm, 10 min

Supernatant (Virus suspension)

Purification Procedure for RRSV
(Modified from Omura, 1983)

Fresh infected including root (300 g)

Homogenize with 0.1 M PB (pH 7.0) + 0.01 M $MgCl_2$
Filterate through cheese cloth
Overnight in freezer
Defrost at room temperature
8,000 rpm, 15 min

Sup

Add 1% Triton X-100
Stir 30 min
8,000 rpm, 15 min

Sup

Add 6% PEG 6000, 0.3 M NaCl
Stir 40 min
14,000 rpm, 40 min

Pellet

Suspend in 40 ml 0.1 M Histidine buffer + 0.01 M $MgCl_2$ (pH 7.0)
Overnight in a refrigerator

Suspension

8,000 rpm, 15 min

Sup

Add 20% CCl_4, stir for 15 min
8,000 rpm, 15 min

Water layer

40,000 rpm, 60 min

Pellet

Suspend in 0.1 M Histidine $MgCl_2$ buffer
Incubate 3 hrs (or overnight) in a refrigerator

Suspension

8,000 rpm, 15 min

Sup

20-50% SDG in 0.1 M Histidine $MgCl_2$ buffer
25,000 rpm, 90 min
Collect virus zone
40,000 rpm, 60 min

Pellet

Suspend in 1 ml 0.1 M Histidine $MgCl_2$ buffer
8,000 rpm, 10 min

Sup

Purified virus suspension

ANNEXURE 5A

USAID "BOTTLENECK" PROJECT

SUBCONTRACT BETWEEN THE REGENTS OF THE UNIVERSITY OF MINNESOTA AND IRRI

SUBCONTRACT BETWEEN THE
REGENTS OF THE UNIVERSITY OF MINNESOTA
MINNEAPOLIS, MINNESOTA

(hereinafter referred to as the UNIVERSITY)

AND

INTERNATIONAL RICE RESEARCH INSTITUTE

(hereinafter referred to as the SUBCONTRACTOR)

Subcontract Title: Removing Soil Structural Constraints to the Production of Maize and Legume Following Rice

Principal Investigator: Dr. Terry Woodhead

Cost Estimate: $41,593.00

Effective Dates: September 15, 1986 - September 30, 1989

This agreement has been prepared for the consideration and approval of the SUBCONTRACTOR. It will become a subcontract in full force and effect upon execution by a duly authorized representative and/or officer of the SUBCONTRACTOR.

This subcontract is entered into in connection with, and under the conditions and terms of, Contract Number USDA-86-CRSR-2-2899 awarded to the UNIVERSITY by the U.S. Department of Agriculture, Washington, DC 20251.

In witness whereof, the parties have hereunto set their hands and each warrants that he is empowered and authorized to execute this subcontract.

REGENTS OF THE UNIVERSITY OF MINNESOTA	SUBCONTRACTOR
By:____________________	By:____________________
Title: Assistant Director Research Administration	Title:____________________
Date:____________________	Date:____________________

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ARTICLE I - Statement of Work

A. The SUBCONTRACTOR hereby undertakes and agrees to furnish all necessary personnel, services, and facilities to perform satisfactorily the research, development as provided hereunder.

B. The attached Appendix A (Statement of Work, original proposal) describes the work to be undertaken.

ARTICLE II - Payment

A. Detailed, certified and correct monthly invoices will be submitted to the UNIVERSITY by the SUBCONTRACTOR for payment. Payment shall be made for actual costs incurred by the SUBCONTRACTOR under the terms of the subcontract not to exceed the Cost Estimate listed on page 1.

B. The UNIVERSITY shall not be liable to reimburse the SUBCONTRACTOR for costs incurred in excess of the Cost Estimate, and the SUBCONTRACTOR shall not be obligated to continue performance under this subcontract or to incur costs in excess of said amount unless and until the UNIVERSITY shall first agree in a writing signed by a duly authorized representative of the UNIVERSITY and the SUBCONTRACTOR to increase said Cost Estimate.

C. Expenditures will not be ineligible for payment solely because of minor deviations from the amount or nature of the expenditure as set forth in ARTICLE III, provided that the expenditures in question are made in connection with ARTICLE I and are of such a nature to qualify as eligible under ARTICLE I. A minor deviation is defined as being ten percent (10%) or less of any one line-budgeted item.

D. The term "costs" as used in this subcontract includes: 1) the cost of direct labor and technical supervision; 2) the cost of materials consumed in the investigation and also miscellaneous charges including (where applicable) but not limited: freight, express, telephone and telegraph charges, traveling expenses, and other similar charges. Indirect costs are not allowed.

ARTICLE III - Budget

A. Exhibit B, attached, represents the approved budget for this subcontract.

ARTICLE IV - Modifications

A. Any alterations, variations, modifications or waivers of terms of this subcontract shall be binding only upon being reduced to a writing signed by a duly authorized representative of the UNIVERSITY and the SUBCONTRACTOR.

ARTICLE V - Termination

A. This subcontract may be terminated by either party hereto by giving written notice to the other party thirty (30) days in advance of a specified date of termination.

B. Upon receipt of such a notice from the UNIVERSITY, the SUBCONTRACTOR shall take all necessary action to cancel outstanding purchase orders and other commitments relating to the work under this subcontract, and shall exercise reasonable diligence to cancel or redirect commitments for personal services to its other activities and operations.

C. The UNIVERSITY shall remain liable for all costs incurred under this subcontract, including any of the above-mentioned commitments entered into by the SUBCONTRACTOR in good faith prior to the receipt of the above-mentioned notice. Upon payment of such costs, the UNIVERSITY shall be entitled, and the SUBCONTRACTOR agrees to deliver, all information and items which, if the subcontract had been completed, would have been required to be furnished to the UNIVERSITY, including, but not limited to, partially completed plans, drawings, data, documents, surveys, maps, reports, and models.

ARTICLE VI - Records and Inspection

A. The UNIVERSITY, Department of Agriculture,, or any duly authorized audit representative, shall have access for the purpose of audit and examination to any books, documents, papers and records of the SUBCONTRACTOR which are pertinent to the subcontract, at all reasonable times during the period of retention provided for in Paragraph C below.

B. All pertinent records and books of accounts related to this subcontract in the possession of the SUBCONTRACTOR shall be preserved for a period of three (3) years after the end of the subcontract period.

C. Records relating to any litigation or claim arising out of the performance of this sucontract, or costs and expenses of this subcontract to which exception has been taken as a result of inspection or audit shall be retained by the SUBCONTRACTOR until such litigation, claim or exception has been disposed of.

ARTICLE VII - Sub-subcontracts

A. The SUBCONTRACTOR shall not enter into sub-subcontracts for any of the work contemplated under ARTICLE I without obtaining prior approval in writing signed by duly authorized representatives of the UNIVERSITY.

B. Such sub-subcontracts shall be subject to such conditions and provisions as the UNIVERSITY may deem necessary; provided, however,

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that notwithstanding the foregoing, unless otherwise not provided in this subcontract, such prior written approval shall not be required for the purchase by the SUBCONTRACTOR for articles, supplies and services which are incidental but necessary for the performance of the work required under ARTICLE I; and provided, further, however, that no provision of this ARTICLE and no such approval by the UNIVERSITY of any subcontract shall be deemed in any event or in any manner to provide for the incurrence of any obligation of the UNIVERSITY in addition to the Cost Estimate on page 1.

ARTICLE VIII - General Provisions

A. All applicable terms and conditions of prime contract 86-CRSR-2-2899 are hereby incorporated by reference (Appendix C).

ARTICLE IX - Publication and Copyright

A. The SUBCONTRACTOR agrees that papers intended for publication in any medium shall be submitted to the UNIVERSITY simultaneously with submission for publication. The UNIVERSITY reserves the right to comment on any such manuscripts in order that the Principal Investigator may make informed decisions concerning final publication of the research results. Review of papers is for comment and not for approval.

ARTICLE X - Patents and Inventions

A. The SUBCONTRACTOR may retain the entire right, title, and interest throughout the world to each subject invention of the SUBCONTRACTOR conceived or first actually reduced to practice in the performance of work under this subcontract subject to the provisions of OMB Circular A-124 and 35 U.S.C. 203. With respect to any subject invention in which the SUBCONTRACTOR retains title, the Federal Government shall have a nonexclusive, nontransferable, irrevocable, paid-up license to practice or have practiced for or on behalf of the United States the subject invention throughout the world.

ARTICLE XI - Civil Rights Assurance

A. The SUBCONTRACTOR hereby affirms that the Assurance of Compliance under Title VI of the Civil Rights Act of 1964 (P. L. 88-352), previously executed, is fully applicable to this subcontract and to any programs assisted thereby.

ARTICLE XII - Acknowledgment of Support

A. Any material published by the SUBCONTRACTOR as a result of this subcontract must contain an appropriate acknowledgment of support by the U.S. Department of Agriculture through the UNIVERSITY with a statement substantially as follows:

"This (material) was prepared with the support of USDA agreement number 86-CRSR-2-2899. Any opinions, findings, conclusions or recommendations expressed herein are those of the International Rice Research Institute and do not necessarily reflect the views of the U.S. Department of Agriculture."

ARTICLE XIII - Key Personnel

A. It having been determined that the individuals, if any, whose names appear in Paragraph B of this ARTICLE, or other individuals mutually acceptable as persons of substantially equal abilities and qualifications, are necessary for the successful performance of this subcontract, the SUBCONTRACTOR agrees, insofar as it is able, to make available such employees or persons for the performance of the work under this subcontract, the SUBCONTRACTOR shall use its best efforts to replace such employees with an employee of substantially equal abilities and qualifications.

ARTICLE XIV - Jurisdiction

A. The SUBCONTRACTOR agrees it will be bound by the laws of this State of Minnesota in all disputes arising out of this subcontract.

ARTICLE XV - Contract Complete

A. This subcontract contains all agreements and covenants between the UNIVERSITY and the SUBCONTRACTOR. All items incorporated by reference are to be attached. No other understandings, oral or otherwise, regarding the subject matter of this subcontract shall be deemed to exist or to bind either of the parties hereto.

ARTICLE XVI - Prohibition of Use of Human Subjects

A. Notwithstanding any other provision contained in this contract, or incorporated by reference herein, the contractor is expressly forbidden to use human subjects in any manner whatsoever. The contractor agrees not to come into contact with, use, or employ, any human subjects for research, experimentation, tests or other treatment under the scope of work as set out in this contract.

APPENDIX B

International Rice Research Institute

REVISED BUDGET

Year	1	2	3	4
Travel & Accomodation to IRRI (USA Res.)	$ 1,000.00	$ 1,000.00	$ 1,000.00	$ 3,000.00
Travel & Accomodation to USA (IRRI)	6,000.00	8,000.00	6,000.00	20,000.00
Hourly Paid (IRRI) Labor	6,000.00	6,000.00	5,000.00	17,000.00
Field Expenses (IRRI)	1,000.00	593.00		1,593.00
Total	$14,000.00	$14,593.00	$12,000.00	$41,593.00

APPENDIX A

STATEMENT OF WORK TO BE UNDERTAKEN BY IRRI's PHYSICS UNIT OF SOILS DEPARTMENT ON USDA BOTTLENECKS PROJECT

Removing soil-structural constraints to the production of maize and legumes following rice.

(Numbers in brackets cite the appropriate page in the project proposal)

1. Plan, direct, oversee, and undertake all the Project's field-crop experiments (both in IRRI Experimental Farm and on farmers' fields), including the provision of the necessary supervisory staff, labourer staff, and plant-pest-monitoring staff, and make necessary arrangements with cooperating farmers (pp. 5, 6, 9).

2. Develop and evaluate appropriate tillage implements, and measure their required draft forces and energy requirements (p. 5)

3. Measure soil friability in the pertinent experiments (p. 6)

4. Collect, grind and ship to Minnesota samples of appropriate Philippine (and possibly Indonesian) soils (pp. 6, 9).

5. Multiply and make available seeds of the appropriate maize and legume varieties (p. 6).

6. Provide IRRI technical/research staff to work in University of Minnesota campus on (a) measurment of soil strength by modulus of rupture (pp. 5, 6) and pneumatic fracture (p. 6); (b) on effects of temperature, pF and aggregate size on mungbean emergence (pp. 6, 7); (c) on pressures exerted by mungbean seedlings (p. 7).

7. Undertake numerical and graphical analyses of results of the Project's field and laboratory experiments (pp. 6, 7).

8. Provide secretarial support as needed (p. 9).

9. Provide residential, office and laboratory accommodation and personal and field transport for University of Minnesota staff visiting IRRI.

10. Maintain scientific liaison through visits to University of Minnesota of Dr. T. Woodhead for program consultation.

Title of project

Removing soil-structural constraints to the production of maize and legumes following rice.

Justification and interface with research already under way

Several Asian rice producing countries are spending large sums of foreign exchange on imports of maize and legumes for human and animal consumption. Expansion of local production of these crops to reduce or eliminate the imports has high national program priority.

In most of the monsoonal rice-producing countries, there is after the harvest of rainfed rice from bunded, puddled fields usually plentiful moisture in the soil profile beneath the puddled layer. That water would be available to a follow-on dry season crop of maize or legume provided that the crop established quickly and that its roots, and oxygen, could quickly penetrate through the drying puddled layer and its associated compacted zone to the moist subsoil below. Development of appropriate techniques of tillage and soil management to help roots exploit this soil water was one of the high-priority recommendations made at the December 1984 International Workshop of Physical Aspects of Soil Management in Rice-based Cropping Systems (PASMIRCS). Preliminary experiments at IRRI using novel and economical techniques of deep tillage have shown that, without fertilizer or irrigation, dry-season mungbean immediately following rice can establish well and can achieve grain and fodder yields of 2.0 and 10 t/ha, respectively (average national mungbean grain yields are about 0.6 to 0.8 t/ha).

In rainfed upland (non-bunded) systems also, legumes are grown after the wet-season rice crop, and rapid soil drying affects seed germiation, soil strength and hydraulic conductivity and hence crop-water uptake and yield. Brazilian research in such upland systems has shown that deep tillage using large tractors can give considerable increases of production. For the small farmers of Asia and Africa, these techniques need to be researched and realized in appropriate-scale technology.

The preliminary experiments at IRRI showed a need for a better understanding of the soil mechanics, both of the deep tines' interactions with the layered puddled soil and of the merging roots' microscale interactions with the (possibly oxygen-depleted) seedbed structure. The understanding of tine interactions (with the objective of reducing specific resistance to soil disturbance so that animal-powered operations shall be possible) might be advanced by the application of shear strength concepts. Studies of the root interactions shall require the development (i) of laboratory apparatus and techniques to measure pressures exerted by growing roots and (ii) of field equipment to measure soil shear strength at the microscale.

Constraints on germination, emergence and early root growth are set by seedbed structure and aggregation through their effects on water release and transmission, aeration, temperature, and shear strength. These constraints, and consequently the tillage technology that overcomes them, will depend on soil type (including clay mineralogy), and research and technology must be so developed as to allow generalization of findings and applications.

The constraints that prevent IRRI from quickly solving these problems of restructuring a puddled soil are three: lack of scientific and technical manpower (IRRI has only one professional physicist, and he must research other topics as well as soil structure regeneration), lack of specialist equipment (such as a tri-axial test rig, x-ray diffraction equipment, uniaxial compression and pneumatic tensile strength cells, equipment for field measurement of shear strength at the microscale), and lack of computing packages that incorporate the pertinent physical and engineering theory. Collaboration with the Soil Physics Group at the University of Minnesota could overcome the constraints that hamper IRRI's implementation of this program.

The program would have deliberate interface with research already under way in IRRI and in collaborating laboratories in Reading (England), Palmerston North (New Zealand), and Wageningen (The Netherlands). The Reading work is concerned with effects of soil-water potential on the germination of pertinent varieties of mungbean and soybean, and the Palmerston studies with adaptation of a new concept in seedling methodology to small-farmer technology. The Netherlands investigations relate to the adaption for rice soils of new techniques for measuring the values and the variability of soil-physical variables that affect seeding, emergence, and tillage. Follow-up and implementation of the findings from the project here proposed (and from the Reading, Palmerston, and Wageningen projects) will be carried through by physical soil scientists from the national research services in the rice-producing countries -- during the 1984 PASMIRCS workshop these scientists indicated their willingness to undertake such studies in their own home institutes. Follow-up might first be made in India, where there is considerable expertise in soil physics, and subsequently in Bangladesh, China, Indonesia, Korea, the Philippines, and Sri Lanka.

Objectives

1. To develop, for previously-puddled soils of various textures at various water contents, a methodology to use tensile strength measurements to predict the energy inputs, soil disturbance, and hence specific resistance for tillage operations (including zero tillage) that promote effective rooting and high yields of maize, mungbean, or soybean following rice.

2. To relate, for previously-puddled soils at various water contents, input of tillage energy and pre-tillage topsoil friability to soil-structural characteristics of the resulting tilled seedbed, and to measure interactive effects of seedbed structure, water content, and temperature on emergence of maize, mungbean, and soybean.

Literature review

Tillage for non-rice crops should produce a soil structure suitable for seed intrusion and for crop establishment, should enusre a good rooting medium of low mechanical impedance and high porosity throughout the crop's development phases, and may need to incorporate crop residues and soil amendments (Cooper, 1971; Kuiper, 1974). Wet tillage (puddling) for rice also achieves some of these results, but additionally, puddling destroys soil aggregates, reduces water percolation, retains impounded water, and creates a soft medium for transplanted rice seedlings (Lal, 1985; Sharma and de Datta, 1985; Zandstra, 1978).

After the end of monsoon rains, when these puddled soils no longer have impounded water, they are often required to grow maize or legumes. However, their lack of aggregates and of wide continuous pores, their increase in bulk density and shear strength on drying, and their proneness to waterlogging -- all these factors make puddled soils ill-suited structurally to the follow-on crops (Bouma, 1969; Scheltems, 1974; Maghari and Woodhead, 1984). The proneness to waterlogging is exemplified by data from Herrera and Zandstra (1977) which show that two days' flooding may reduce germination rate of mungbean and soybean by more than nine-tenths, and of maize by about three-fourths. Seeding into ridges (Zandstra, 1978) and application of calcium peroxide (Ogunremi et al., 1981) are two methods to reduce the adverse effects of waterlogging for follow-on crops in rice-based cropping systems.

Rapid drying of seedbeds, in both puddled and upland soils, may also reduce rates of germination and emergence in maize and legumes -- particularly in years when the ending of the monsoon is abrupt. In such situations the timeliness of tillage operations and consequent minimization of turnaround time (the interval between rice harvest and maize or legume planting) are of paramount importance. Data of Maghari and Woodhead (1984) for previously puddled soils showed that emergence (from cloddy-tineplowed seeedbeds) of maize planted four days after simulated rice harvest was 50%, comparted to 80% for seeds direct-drilled one day after harvest. For mungbean in the same soil, emergence rate from a tilled and rolled seedbed declined from 90 to 85% when planting delay (after field-draining) increased from four to six days. For upland mungbean soil, de San Agustin and Woodhead (1985) showed that emergence of mungbean declined from 65 to 4% when seedbed moisture declined from 0.27 to 0.23 kg/kg during a seven-day interval between successive plantings.

Growth-chamber studies by Schneider and Gupta (1985) showed that maize emergence was most rapid for soils at or above field capacity. Moreover, in conditions which simulated the northern U.S. corn belt, the effect of low temperature was dominant; supporting studies (Gupta, Larson, and Allmaras, 1984) showed that soil temperature could be manipulated by mangement of surface residues. These effects of low temperature are relevant for rice-base cropped systems in regions further from the equator -- as in China, India, Korea, and Nepal. For equatorial regions, e.g., Indonesia, the Philippines, Thailand, parts of Africa and Latin America, high rather than low temperatures may inhibit germination and emergence. Recent growth-chamber studies by Fortuno and Woodhead (unpublished) measured interactive effects of soil temperature, water potential and pH on emergence of different varieties of mungbean, soybean, and upland rice. For all species and varieties, emergence was negligible above 40^{o}C; for mungbean (as reported in de San Agustin and Woodhead, 1985) emergence was reduced by nine-tenths when soil was dried to -0.6 MPa. Effects of soil temperature on root growth in rice-wheat systems were discussed by Singh, Aggarwal, and Woodhead (1985); growth of rice roots decreased rapidly as daytime temperature increased from 37^{o} to 42^{o}C. Results of de San Agustin and Woodhead (1985) showed that afternoon temperatures in upland soils under rice reach 36^{o}C at 5 cm and 38^{o}C at 2 cm even in the wet season; soil temperatures in the dry season are likely to be somewhat higher.

Seedbed structure for dryland crops following rice, and the applicability of aggregate classifications, and the effect of soil texture and mineralogy were reviewed by Emerson (1985) and by Prihar et al., (1985). For effective emergence of maize, Larson (1964) and Schneider and Gupta (1985) respectively showed that aggregates should be less than 5 or between 1.0 and 6.8 mm in geometric mean diameter.

The tillage methodologies to achieve the required seedbeds and the influence of soil-water content at the time of tillage were discussed by Kisu, who presented (1978, p. 313, Fig. 3) the data of Kutsuna et al. (1974) which showed that, for a loam soil, pulverization decreased as water content increased, but that nonetheless soil could be pulverized even when wetter than the liquid limit. For deep tillage of puddled soils, Spoor, Cochran, and Chakkaphak (1985) and Dexter and Woodhead (1985) discussed appropriate methods and the constraints of critical depth. Field measurements (Maghari and Woodhead, 1984) showed that the draft forces needed to cause soil disturbance to 35 cm in a puddled vertic Tropaquept soil at about 0.45 v/v water content (plastic limit$\sim$0.35, liquid limit$\sim$0.50) were 6 kN for a single narrow tine, and 9 kN for a winged tine with two shallower leading tines. Gupta, Kumar, and Singh (1984) and Prihar et al. (1985) summarized the soil-physical data collected in Indian experiments that showed wheat yields to increase in response to deep-tine tillage. For mungbean, Maghari and Woodhead (1984) obtained very high yield (2.1 t/ha) in response to deep strip tillage, but yield was almost as high 1.9 t/ha) after conventional plowing and harrowing. These overall high yields (in comparison to local practice) may be a consequence of effective seedbed preparation that resulted in uniform crops that efficiently intercepted solar irradiance, and of minimal tunraround time that allowed the extending roots to encounter the layers of high soil strength before they had dried to impenetrable hardness. Effects of soil strength, and of soil oxygen, on root extension in puddled soils, and the formation of the strong layers in such soils, were reviewed respectively by Singh, Aggarawal, and Woodhead (1985) and by Prihar et al. (1985). Microscale techniques for measuring the shear strength of seedbed soil structures have been developed by Collis-George and Lloyd (1978), and cells for measuring the pressures exerted by extending roots have been built and described by Goss (1977) and by Whiteley, Utomo, and Dexter (1981).

The ability of a soil mass to break up during tillage is determined by its <u>tensile strength</u>. The tendency for the soil to break down into fragments of a particular <u>size range</u> may be defined as friability (Utomo and Dexter, 1981). Tensile strength is difficult to measure directly, but from indirect measurements that used compressive forces, Utomo and Dexter (1981) concluded that the water content that gives most fragmentation during tillage and that gives highest friability in laboratory tests is about 0.9 x Casagrande Plastic Limit. However, the method of measuring tensile strength used by Utomo and Dexter assumes that soil elasticity is the same in compression as in tension. This assumption does not hold in soils (Farrell, Greacen, and Larson, 1967). An improved and direct method of measuring tensile strength has been developed by Snyder and Miller (1985). It does not assume equality of elasticities, does not require measurement of sample dimensions, and avoids bending moments that can constitute sources of error.

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For dryland rice or legumes, a major function of tillage is weed control (Harwood, 1979; Moody, 1983). Data of de San Agustin and Woodhead (1985) confirm earlier findings that the production fo weed mass is at the expense of a roughly equivalent mass of rice plants. Weed mass generally is less when tillage is more intense (Shetty and Moody, 1982).

Procedures and research plan

In a three-year project, two scientists from the University of Minnsota Department of Soil Science would collaborate at IRRI in field work in IRRI's experimental farm and in farmers' fields and in laboratory and controlled environment studies. Soil samples and data would be analyzed in Minnesota using speciailzed equipment and existing computer packages of soil mechanical theory. Purpose-designed equipment (e.g. for root pressure studies and tensile strength) would be designed and built in the University of Minnesota machine shops. IRRI senior tehcnical and research-support staff would collaborate in Minnesota using the appropriate technologies, science, and computing so that IRRI would have a continuing expertise after the collaboration's completion.

The project's two objectives shall be pursued as follows:

Objective 1. (Tensile strength and tillage)

Tensile strength will be measured, using pneumatic fracture (Snyder and Miller, 1985: Fig. 1) and modulus of rupture (Richards, 1953) techniques, for soil taken at 0-10, 10-20, 20-30, 30-40, and 40-50 cm depth for each of about eight puddled rice soils of differing textures. The measurements would be made for a range of soil-water potentials; they would be carried out in Minnesota, on soil samples initially air-dried, ground, and sieved (2 mm) at IRRI. Equipment for the pneumatic fracture technique shall be constructed in the machine shop at Minnesota; the Instron uniaxial compression cell needed for the rupture tests is already available at Minnesota. In field trials on the same soils, and at various water contents imposed by a line-source sprinkler system, draft force for various prototype tine systems operating at various depths will be measured using a two-tractor system with a calibrated dynamometer link; resulting soil disturbance will be determined through trench excavations to give values for specific resistance. Soils at all test sites will be characterized by IRRI specialists in terms of USDA Soil Taxonomy.

Emergence, rooting, and crop growth and yield for the upland crops following rice in puddled soils subjected to different tillage operations shall be monitored in ongoing IRRI experiments that include a large component of soil-physical measurements -- amongst which aggregate size distribution, soil temperature, strength, and water content feature prominently. Less-instrumented trials shall be undertaken in farmers' fields. Tillage treatments shall be made using deep tines of various designs, moldboard plow/harrow, ridging plow, and direct seed-dibbler. If resources permit, effects of mulch shall also be studied.

Objective 2. (Soil friability and seedbed structure)

Soil friability for the 0-10 cm layer of the previously puddled soils shall be measured at a range of soil-water potentials by the method of Utomo and Dexter

(1981). Soil-moisture retention characteristics shall be determined for the same soil layers, so that the water potential corresponding to maximum friability shall be interpreable in terms of waer content. Aggregate size distribution and pulverization indices (Kutsuna et al., 1974) shall be determined for seedbeds created under optimal water conditions by a standard rotary cultivator operating for various set times to simulate various inputs of tillage energy. Shear strength of seedbeds shall be measured using microscale equipment (to be constructed in Minnesota) of the type described by Collis-George and Lloyd (1978).

In growth-chamber experiments (in both Minnesota and IRRI), measurements will be made of the effects on emergence of maize, mungbean, and soybean of aggregate size distribution and of soil-water potential and temperature. By combining different proportions of sieved aggregates of various defined sizes, size distributions shall be created (Schneider and Gupta, 1985) that shall range around the distributions found optimal in the field-tillage and friability tests. The various aggregate mixtures shall be poured into pairs of matching open-ended cylinders, one filled completely, the other to 50 mm. (planting depth). Aggregates in each of the paired cylinders shall be packed to a standard dry bulk density, then saturated, and then dried to one of four specific matric potentials on a pressure-plate apparatus. Seeds shall then be placed on top of the soil in the filled cylinder, and the partially filled cylinder placed above them, so that the seeds are in firm contact with soil both above and below. The two cylinders shall then be taped together, and placed in a growth chamber at one of five chosen regimes of day/night temperatures. Emergence rates and plant height shall be measured. Strength of the aggregate mixtures shall be determined using a small diameter cone penetrometer.

Force exerted by extending radicles of maize, mungbean, and soybean shall be measured using the anchored seed/free-moving balance technique of Whitely, Utomo, and Dexter (1981). Pressures exerted by older roots shall be measured in cells similar to those developed by Goss (1977). The various equipment needed shall be constructed at Minnesota.

Analysis and Interpretation

Objective 1. (Tensile strength and tillage)

Tensile strength values determined by modulus of rupture shall be compared graphically and analytically with values derived by pneumatic fracture. For either technique, and for each soil layer and type, tensile strength shall be related to water content, and water content determined that corresponds to minimum strength. Soil-mechanical theory shall be applied if possible to relate draft-force requirements of different tillage regimes (including zero tillage and ridging) imposed in field interpretations shall be quantified through analyses of variance. Deterministic interpretations shall be sought through application of the SWATRE model of Feddes, Kowalik, and Zaradny (1978).

Generalization of findings shall be sought in relations to soil texture, clay mineralogy, and soil taxonomy.

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Objective 2. (Soil friability and seedbed structure)

Tillage draft forces shall be measured directly; inputs of tillage energy may be calculated from draft x distance worked and (approximately) from energy delivered by tractive power unit x efficiency factor. The draft forces (or energies) and the pre-tillage friabilities shall be related to quantitative characteristics of the resulting seedbed structure by multiple correlation analysis. Deterministic relations shall be sought if the correlation analyses show sufficient promise.

Multiple correlation shall also be used to relate totals of seed emergence, and time for emergence, to seedbed structure, microscale strength, water content and temperature, and to seed/aggregate size ratio.

Radicle forces and root pressures shall be compared to seedbed microscale strength and to the measurements of resistance to cone penetrometer that support the growth-chamber studies using aggregate mixtures. These findings shall be generalized in relation to existing unpublished data sets of penetrometer index/water content/bulk density in previously puddled soils. Findings will help determine soils and conditions suitable for zero-tillage production of maize, mungbean, and soybean.

Feasibility, limitation, and the "bottleneck"

All of the techniques and methods that would be employed in the proposed research have been adequately developed and proven in temperate-latitude research. Their adaption to tropical soils and conditions, though novel, should be entirely feasible. Statistical analyses of data can proceed through standard techniques. Deterministic analyses in terms of soil mechanics will be taken as far as limitations of current theory allow. The University of Minnesota has in its Soil Science and other departments a body of expertise in soil mechanics that can supplement that of the applicants if and when necessary.

This input of soil-mechanics theory and expertise shall be as important as the provision of specialist equipment in the "widening of the bottleneck" that would be achieved by this proposed research.

Current research

Ongoing and proposed research of this proposal's authors include (i) guidelines on the susceptibility of soils to excessive compaction, (ii) effects of tillage and planting depth on the emergence of maize, (iii) guidelines on the slope and orientation of ridges to maximize maize emergence, (iv) effect of tillage on shear strength and erosion of soils, and (v) guidelines on the suitability of tillage systems in relation to the hydrology of soils.

Information and data obtained from the proposed "bottlenecks" project would support and be supported by this ongoing and proposed research. Thus, tensile strength measurements are pertinent to rice-soil tillage and to the erosion study, and root pressure-penetration resistance relationships are needed both to understand emergence of tropical legumes and to define excessive compaction in U.S. soils. Similar principles and research methods apply to the emergence both of maize in the U.S. corn belt and of dryland crops following rice.

Facilities, equipment, funding, and budget

The University of Minnesota Department of Soil Science has tow laboratories (approximately 600 m^2), a direct shear machine, soil moisture equipment, and various standard soil physics equipment. An Instron University soil testing maching (for shear strength and penetration resistance measurements), compression cells, a microdesensitometer for measuring roots length, and other soil-mechanics equipment are similarly avilable. Computer facilities at the University of Minnesota include a CDC Cyber 74, Cray and three microcomputers/terminals in the Soil Physics laboratories. Facilities for routine soil physical, chemical, and clay mineral analysis (x-ray, differential thermal analysis) and several gerowth chambers are available in the Department to support various aspects of the proposed studies. Excellent machine shop facilities are located on the campus; they would be used for construction of special-purpose instruments and apparatus. Field experimental sites on a range of soils, and appropriate field equipment are available at the University and at nearby ARS facilities; these may be used where appropriate to develop techniques and to provide soil in simulation of tropical conditions.

Funding is required for research assistant help in Minnesota, for journeys between the USA and IRRI for the U.S. researchers and one U.S. technician, and for those staff's enroute and IRRI accommodation expenses. There shall be costs of visits to the USA for one IRRI staff scientists (for two- to three-week periods) and for two IRRI senior tehcnical research support staff (for two- to three-month periods), and these shall be IRRI permanent employees. To maintain continuity of work while these support staff are in the USA and to give necessary support at IRRI to the U.S. researchers, hourly-paid labor and secretarial help shall be required.

There shall also be some costs (incurred both in the USA and in IRRI) of reagents, field-trial and machine-shop materials, some small items of equipment, and a soil grinder. (Grinding of soil could be undertaken either in Minnesota or at IRRI. However, since labor costs are lower in the Philippines, and since ground, dry soil will be less expensive to air-freight than moist bulk soil, it is proposed to grind the soil at IRRI. Freighting of dry, ground soil, is also preferred on quarantine considerations. However, IRRI's soil-grinding capability is already fully extended, and it is therefore proposed that an additional grinder, to be sited at IRRI, should be purchased using these project funds).

The various costs are summarized in the appended budget.

Research timetable

Year:	1		2		3	
Season:	Wet	Dry	Wet	Dry	Wet	Dry
Soil collection	x	x	x			
Aggregates mixing	x	x	x			
Equipment construction	x	x				
Friability tests	x		x			
Tensile strength		x	x		x	
Draft/energy trials		x		x		
Growth/yield trials		x		x		
Emergence (growth chamber)		x	x	x	x	
Root pressure (lab)	x		x			
Program review	x	x		x		x
Analysis				x	x	x
Report writing					x	x

ANNEXURE 5B

PROGRESS REPORT

USAID "BOTTLENECK" PROJECT

REMOVING SOIL STRUCTURAL CONSTRAINTS TO THE PRODUCTION OF MAIZE AND LEGUMES FOLLOWING RICE

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"REMOVING SOIL STRUCTURAL CONSTRAINTS TO THE PRODUCTION OF MAIZE AND LEGUMES FOLLOWING RICE"

Soil Science Department, University of Minnesota :
IRRI Physics Unit of Soils Department

(Report at 23 October 1986)

The "Bottlenecks" project on "Removing soil structural constraints to the production of maize and legumes following rice" became operational on 15 September 1986. However, prior to that date, in June 1985, May 1986 and July 1986, Dr T. Woodhead of IRRI visited Profs Larson and Gupta at University of Minnesota for project-planning purposes; during the second of the visits, Dr Woodhead carried Philippine soil samples to Minnesota. There is, as direct result of the visits, an agreed work plan for the period July 1986 - June 1987.

Profs Larson and Gupta have assembled the various specialist equipments for measuring soil strength (notably the pneumatic fracture cell) and for measuring root-extension pressure. They have also recruited as assistant to the project a soil science graduate who shall undertake M.S. training within the project. Contacts have been made with Professor Collis-George, University of Sydney, Australia, who has kindly sent to Minnesota workshop drawings to enable construction of a microscale shear stress cell for measuring strength of seedbed soil.

On 28 September 1986, Miss S. Maghari, Research Assistant, IRRI Physics Unit, arrived in Minnesota for a 3-month attachment to carry out detailed measurements applying the Minnesota specialist equipment to Philippine soils. Specifically, measurements have already commenced of the interactive effects of soil aggregate size, soil temperature, and soil-water content on the germination and emergence of Asian varieties of mungbean. It is noteworthy that Miss Maghari also provides part of the IRRI link to the soybean phase of the studies, undertaken collaboratively with Indonesian colleagues at Sukamandi.

The agreed work plan anticipates that Profs Larson and Gupta shall respectively visit IRRI during January 1987 (the tillage and seeding stage of field experiments) and April 1987 (for initial analysis of data immediately post-harvest).

ANNEXURE 6

PROJECT PREPROPOSAL

PRODUCTION OF ETHANOL AND FEED YEAST FROM ACID HYDROLISATES OF RICE HULLS AND RICE STRAW

draft
7/23/86

A Project Preproposal
Program in Science and Technology

PRODUCTION OF ETHANOL AND FEED YEAST FROM ACID HYDROLYSATES OF RICE HULLS AND RICE STRAW

Submitted to

Office of Agricultural and Chemical Development
Tennessee Valley Authority (TVA)
Muscle Schoals, Alabama 35660

by

The National Institutes of Biotechnology and Microbiology (BIOTECH)
University of the Philippines
Los Banos, Laguna

and

The International Rice Research Institute
P.O. Box 933
Manila, Philippines

RESEARCH PROJECT PROPOSAL
Program in Science and Technology Cooperation (PSTC)
U.S. Agency for International Development

1. Project Title: Production of Ethanol and Feed Yeast from Acid Hydrolysates of Rice Hulls and Rice Straw

2. PSTC Research Module: Biomass Resources and Conversion Technology

3. Investigators: Ernesto J. del Rosario, Ph.D.
(Principal Investigator)
National Institutes of Biotechnology and Applied Microbiology (BIOTECH)
University of the Philippines at Los Banos (UPLB)
Laguna, Philippines 3720

William G. padolina, Ph.D.
BIOTECH-UPLB

Bart Duff, Agricultural Economist
International Rice Research Institute
P.O. Box 933, Manila, Philippines

4. Project Objectives:

(a) To optimize the two-stage acid hydrolysis of rice hulls and rice straw;

(b) To optimize production of ethanol and feed yeast from the acid hydrolysates of rice hulls and rice straw;

(c) To evaluate component and system economics and energy balances of acid hydrolysate process for conversion of rice hull and straw.

5. Project duration - 3 years
Proposed starting date - 1 January 1988

6. Research rationale and proposed workplan

Rice hulls and rice straw contain approximately 35-45% cellulose, 20% hemicellulose, 20-30% lignin and 15-20% ash (including silica). Hulls and straw are low value byproducts normally eliminated by open-air combustion which contributes to environmental pollution. Economical utilization of these byproducts in energy conversion systems or through chemical transformation would add value and utility to hull and straw in rice producing countries.

A two step acid hydrolysis of rice hulls and rice straw, as demonstrated by the Tennessee Valley Authority (TVA) Barrier et al., 1985), would allow separate saccharification of the hemicellulose and cellulose fractions. However, modification in the TVA process will allow production not only of ethanol from the acid hydrolysates, but also feed yeast. The hemicellulose hydrolysate, which contains mainly pentose (five-carbon) sugars shall be used for the production of Candida utilis (food yeast). The cellulose hydrolysate, which contains glucose, shall be fermented into ethanol. The unhydrolyzed residue containing lignin shall be dried and used as fuel for generating process steam.

The experimental procedures and hydrolysis reactor design and operating conditions to be used in the proposed project shall follow the design used in the TVA process. Therefore, it is proposed that the project be done in collaboration with the TVA-Office of Agricultural and Chemical Development, Muscle Shoals, Alabama. The acid reactor and other necessary equipment shall be fabricated in the Philippines, as much as possible, using the optimized TVA design. Production of ethanol and Candida yeast shall incorporate technologies currently under development at UPLB-BIOTECH by the principal investigator; these include continuous-flow ethanol fermentation by carrageenan-immobilized yeast. The yeast produced shall be treated with lime in order to reduce its nucleic acid content. This enables greater incorporation of the resulting yeast in human food preparations.

The proposed research is innovative because it explores the more practical utilization of pentose and glucose in producing food yeast and ethanol, respectively. Previous work in this area tried to convert both pentoses and glucose obtained from the hydrolysis of hemicellulose and cellulose into ethanol. However, conversion of pentoses into ethanol remains uneconomical because of low conversion rates and efficiencies.

8. The proposed research is relevant to all rice-growing countries which produce rice hulls and straw. If successful, the research will permit economical utilization of these crop residues in ethanol and food yeast production, instead of creating a waste and pollution problem.

9. Collaborative arrangements shall involve the Tennessee Valley Authority (TVA)-Office of Agricultural and Chemical Development, Muscle Shoals, Alabama, U.S.A., The National Institutes of Biotechnology and Applied Microbiology (BIOTECH) and the International Rice Research Institute (IRRI). The U.S. counterpart shall provide technical designs and expert advice on operation of the acid reactor and accessory equipment, as well as recommendation to further optimize and scale-up the acid hydrolysis system.

10. Budgetary requirements

Item	Year 1	Year 2	Year 3
Salaries	$4,000	$4,500	$5,000
Equipment/ materials (including reagents)	35,000	25,000	15,000
Travel (directly related to the research)	5,000	5,000	3,000
Training/consultation (directly related to the research)	10,000	6,000	3,000
Overhead	10,000	10,000	5,000
Other costs (books and other publications directly related to research)	2,000	1,000	500
Sub-total	$ 66,000	$ 51,500	$ 31,500

TOTAL---$149,000
xxxxxxxx

Literature Cited

Barrier, J.W., P.C. Badger, J.D. Broder, G.E. Farina, M.R. Moore, and M.F. Forsythe, "Experimental Facility Design Report: Integrated Fuel Alcohol Production Systems, "Tennessee Valley Authority - Office of Agricultural and Chemical Development, Muscle Shoals, Alabama, February 1985.

Annexure 7

Interim Progress Report

Gasification of Rice Husk

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(Section VI, Stage I-Phase I) in interim progress report for Contract DPE-5542-G-3044-00.

Economic Feasibility of Small-Scale Rice Husk Gasification

The original project document projected a potential market for small-scale rice husk gasification systems in the Philippines and Indonesia. While the market criteria found in these two countries are unique in several respects, many of the environmental and economic conditions are representative of a larger number of countries in South and Southeast Asia. Therefore, the potential application of small-scale gasifier technology should be viewed in a broader context then portrayed in the present analysis which is restricted to the Philippines and Indonesia.

Overview of Energy and Agriculture

During the period from 1970 to 1984, the world price of oil rose from $1.3 to $29.3 per barrel (IMF). Agriculture in the developing countries was effected in various ways by this rapid rise in pertroleum energy costs. During the first oilshock in 1974, fertilizer prices rose faster than the price of oil. In the late 1970's, as additional fertilizer capacity became available and oil producers began to use low value natural gas in fertilizer production, prices dropped below 1970 levels. They have continued to reside at these levels despite inflationary pressures and moderate increases in oil prices during the first half of the 1980's. World food prices paralleled the early rise in oil prices through 1974, but have shown a declining trend through the late seventies and early eighties (Fig. 1). While rice and wheat production have continued to rise in the developing countries, the net effect of increased energy and input costs (notably fertilizer) and declining commodity prices has been a decline in real incomes in the farm sector.

In the Philippines, which has essentially no natural sources of petroleum, the response to a higher energy bill has been to accelerate development of indigenous energy sources, including exploration of several nonconventional technologiess such as dendro thermal, geothermal, wind, solar and gasification using primarily charcoal or wood residues (Waddley, 1984).

Approximately 50 percent of all rural households now have access to electric power, mostly for lighting purposes. There are, however, many islands and rural locations which have not yet been electrified.

Indonesia has much larger energy reserves than the Philippines and which are available at lower costs. It has been estimated, however, that over half the primary energy in the country is derived from biomass, primarily firewood

(Weingart, 1981). In addition, infrastructure to supply rural areas with electric power is largely undeveloped (Harahap, 1981).

Rice Processing and Rice Husk Availability

Both countries produce large volumes of rice, the primary food commodity for both rural and urban populations (Table 1). The rice processing industry is highly decentralized in both countries and much of the processed product is consumed within a few kilometers of the rice mill (IRRI, 1978). About one-half of total rice production is processed in small mills; either steel hullers (Engelberg) or in small modern roller units. The latter mill produces a segregated output consisting of milled rice, bran and rice husk. The steel huller mill producess milled rice as one fraction and a mixture of bran, rice husk and broken rice as a second fraction. The rice bran-husk mixture is used for animal feed. However, from a technical point of view, the steel huller mill is significantly less efficient than the rubber roll mills and is gradually being replaced in areas where the rubber roll technology can be sustained. Rice hulls are also readily available from almost all commercial mills in both countries. They have an esentially zero opportunity cost.

There are in excess of 20,000 small rubber-roll rice mills operating in Indonesia. These systems process about

50 percent of total rice production. Most are located in rural areas and are powered by small (12-18 hp) diesel engines. On average each mill produces about 150-350 t/yr of waste rice hulls with an energy content of 200-450 BOE.

In the Philippines, there are an estimated 10,000 small rice mills located in rural villages. Of these, approximately 10% or 1000 are rubber roll mills, although this number is increasing as the older steel huller technology is replaced. Each rubber roll will produce 100-150 t/yr of waste rice husk with an energy equivalent of 130-190 barrels of diesel oil.

Few alternative uses for rice husk exist which are economically viable in either Indonesia or the Philippines. In most cases, husk is simply burned.

Research on rice husk gasification is underway at the Nonconventional Energy Research and Development Center of the Ministry of Energy in the Philippines (Wadley, 1984) and in Indonesia at the Bandung Institute of Technology. Both projects are funded by USAID. The Bandung project has focused on both pyrolysis and gasification of husk with some success (Weingart, 1981).

In summary, there exists in both Indonesia and the Philippines a large quantity of unutilized rice husk with very low opportunity cost. Husk is located at decentralized rural locations which presently lack energy for many basic needs such as lighting, food processing and municipal services. Indigenous attempts to tap the technology are underway but have thus far been commercially unsuccessful. The economics of using this resource are the focus of the next section.

Comparative Economics of Rice Husk Gasification

Seckler (1984) in analyzing alternative rural power sources for Indonesia found that existing gasification technologies were not available in the smaller horsepower sizes which could compete economically with diesel engine power (Fig 2). He did show that gasifiers are highly competitive with electrical generating systems. The gasiier design included in the analysis used charcoal which results in a very low energy conversion efficiency and relatively high cost for the feedstock. A technological breakthrough which employs unconverted residues such as rice husk in the gasification process could alter the position of the curve relative to diesel power. A rise in the cost of diesel fuel would have a similar impact.

Evidence from both countries (IRRI, 1978; Handaka, 1981) indicates that the mean size village-level rice milling installation is in the range of 12-18 horsepower.

Tables 3 and 4 contain a comparative analysis of diesel engine installations at small ricemills in the Philippines and Indonesia. Initial investment costs, interest rates and fuel costs are all higher in the Philippines. Costs per horsepower-hour (HPH) are nearly 2-1/2 times those in Indonesia. The biggest disparity is found in fuel costs; a reflection of the scarcity and higher costs of petroleum resources in the Philippines relative to Indonesia.

In Table 5, we have summarized the energy cost per horsepower (HPH) over a range of fuel costs in each country. Clearly the cost of rice processing is directly impacted by the price of diesel fuel. At the current price of $.38/liter in the Philippines, the cost per HPH is about $.092 compared with $.035 in Indonesia. On the basis of this simple examination, it is clear innovations which reduce the energy costs of processing will have a more viable market in the Philippines than in Indonesia. This finding must be qualified, however, by restating the observation that there are many more rice mills in Indonesia which are suitable for rice husk energy conversion than currently exist in the Philippines.

The key question which must be asked is whether increasing the fixed investment in a rice processing plant by installing a rice husk gasifier will offer sufficient savings in diesel fuel costs to induce rice millers to invest in the innovation. We have assumed the gasifier will be retrofitted to existing rice mill-engine systems without increasing the size of the engine or expanding the structure to house the gasifier. We have also assumed that the labor needed to service and monitor the gasifier would be the same operator currently managing the engine and milling equipment in the plant. This assumption implicitly projects no major increase in labor requiremens from use of the gasifier and is a critical design consideration in developing the unit.

The estimated capital costs of a rice husk gasifier with the capacity to fuel a 15 hp diesel engine are given in Table 6. We have assumed in this table that the relative cost of the gasifier in the Philippines compared with Indonesia will be in the same relative ratio as the costs of diesel engines in each country. This assumption is relaxed later in a sensitivity analysis. We have also used a conservative five year life for the gasifier and also assumed that the systems in each country used a comparable number of hours. The latter assumption is questionable given the reportedly larger annual milling outturn of the Indonesian rice mills. The assumption is, however, not critical in comparing alternative energy sources in the same application in the same country.

Calculations in Table 7 provide the conversion relationsships for both rice husk and diesel fuel. We have assumed the engine is fueled using a 70:30 proportion of rice husk to diesel fuel. Higher rates of husk conversion are possible, but will introduce additional problems in the design of efficient gas cleanup equipment, induction components and combustion efficiency. Because labor costs for transport and handling of rice husk as well as the costs of diesel fuel are lower in Indonesia, the energy cost is more favorable.

Cost Effectiveness. The information in Table 8 has been normalized to permit comparison of the gasifier system with other power systems. In this case, the cost of the diesl system becomes the numeraire against which the cost of Alternative Energy Technology (AET) systems can be compared. The ratio indicates the rice husk conversion system is a viable option in both countries under the assumptions used in the analysis. The gasifier technology is more attractive in the Philippines from a cost effectiveness point of view because of the relatively high costs of diesel fuel compared to Indonesia. Even in Indonesia, however, the proposed technology is superior to existing diesel engine installations. These findings are in consonance with those of Seckler (1984).

Sensivity Analysis. Tables 9 and 10 illustrate the effect of varying the target design investment cost of the gasification system in the Philippines and Indonesia. Within the range considered, the gasifier system is profitable in both countries. Even at a cost above $200/hp, rice husk gasification appears viable. As was shown in Table 5, varying the cost of diesel fuel also produced a proportional relationship between rising diesel prices and the attractiveness of shifting to an alternate fuel source.

The AET analysis does not provide a direct measure of rate of return on investment. Clearly this is critical in assessing whether rice mill owners are likely to shift to an AET such as rice husk gasification. We have not included such analysis in the present report because of a paucity of information on operating conditions and capacity utilization in small rice mills in the Philippines and Indonesia. We also have not considered the practicality of employing rice husk gasification in other applications such as irrigation pumping, municipal or village-level electrical generation or industrial processing. These would require estimating the need for a range of gasifiers for which little evidence is available.

RECOMMENDATIONS

This short analysis is not exhaustive nor conclusive. It has been an attempt to examine the potential market for a small-scale rice husk fired gasification unit. The following are the summary findings:

1. The total market for small rice husk gasification systems are likely to be confined to village level rice processing units employing separate rice dehusking and polishing components. These units are a growing proportion of total processing facilities in both Indonesia and the Philippines. It is estimated there exist approximately 20,000 such units in Indonesia and 1,000 in the Philippines. This number is expected to grow as this improved processing technology replaces the traditional single pass steel huller mill in the Philippines and additional milling capacity is added at decentralized locations in Indonesia.

2. The bulk of the market for rice husk gasification systems will be as retrofitted units on existing processing plants. While new installations may utilize the technology in an orginal configuration, these will represent a small part of the total market.

3. The current price of diesel fuel is competetive with existing alternatives as the energy source for small rice

processing plants. Projections for fossil fuel energy prices will, however, rising during the next ten years. This will increase the competative advantage of proposed rice husk gasifier systems in the late 1980s, particularly at remote rural locations where the costs of transport and marketing add to the costs of diesel.

4. The present analysis has not attempted to examine the range of alternative uses of rice husk outside the engine-gasifier system. While the present value of husk is zero or negative at many processing plants, this situation may change in the future as the market for industrial applications emerges in the developing world. Technology exists in the United States and Western Europe to convert rice husk to a wide number of products. However, it is likely industrial users will draw their feed stocks from the larger, commercial rice processing plants located near urban centers and which are accessible to good transport facilities. The small village rice mill is unlikely to be a cost effective source of rice husk for these industries. A comprehensive review of alternative uses for rice husk in the developing countries is, however, a strong recommendation of this review.

5. The budgeting analysis suggests that to achieve a cost advantage over existing diesel engine systems, the

gasifier must adhere to the following design and investment parameters:

a. be capable of supplying a minimum of 70% of the fuel requirements of a 12-18 hp diesel engine system.

b. have an initial investment cost not exceeding $200/HP. For design purposes, the manufacturing cost of the system should be about 50% (or less than $100/HP) of the investment cost.

c. the system should be designed for retrofitting to existing small-scale milling installations with a minimum of modifications in engine induction or combustion components.

d. the system should have the flexibility to operate on 100% diesel fuel if necessary.

e. the system should be capable of continuous operation with no downtime for reloading the gasifier. Either a continuous flow or dual batch-type mechanism should be considered in the design to meet this criteria.

f. because of nonavailability of spare parts and experienced operators, the design should be simple and lend itself to using fabrication from locally available components. Repairs should be sustainable in small shops equipped with minimal equipment such as welding, drilling and bending tools.

g. safety accessories should be incorporated into the design to guard against explosion or contamination of gas entering the engine resulting from inexperienced or careless operators.

Additional economic analysis should be carried out to assess the required rate of return needed to induce millers to invest in the technology. Lessons should also be drawn from the experience with charcoal gasifiers in the Philippines (Waddley, 1984) and other Alternative Energy Technologies which exist or are in development.

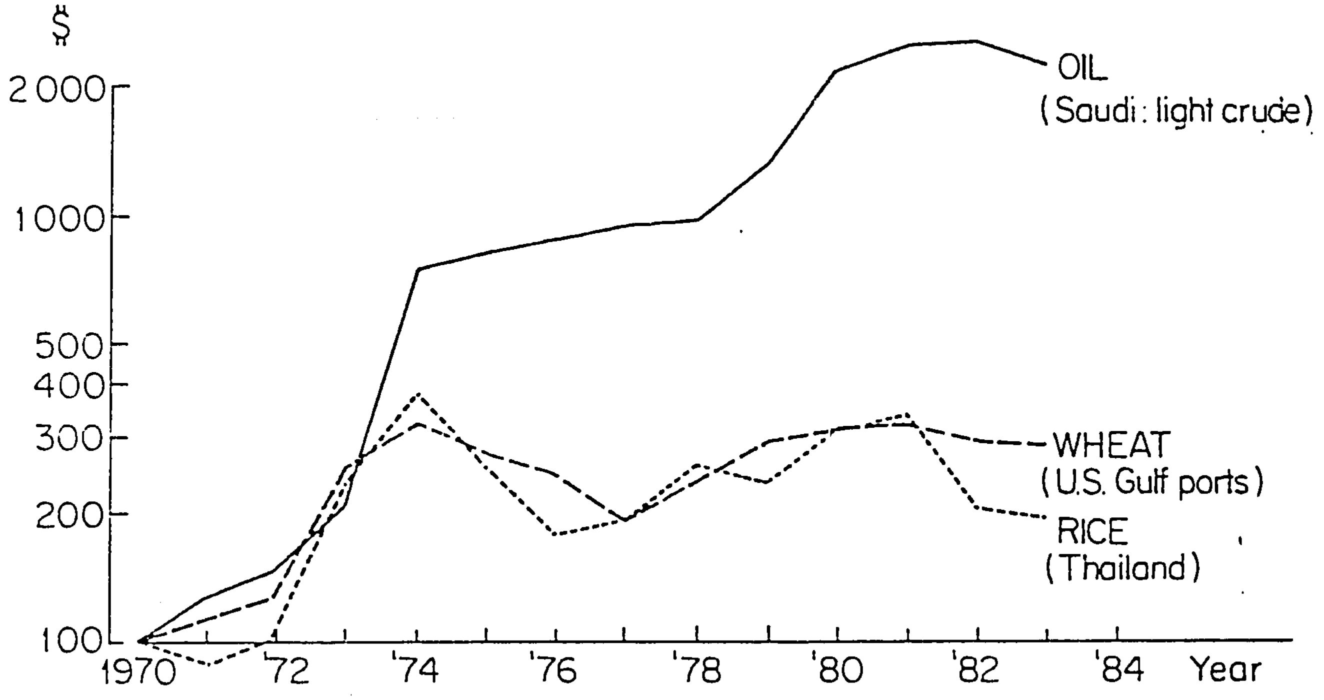

Fig. 1. Indices of world oil, wheat and rice prices (current dollars, 1970 = 100)

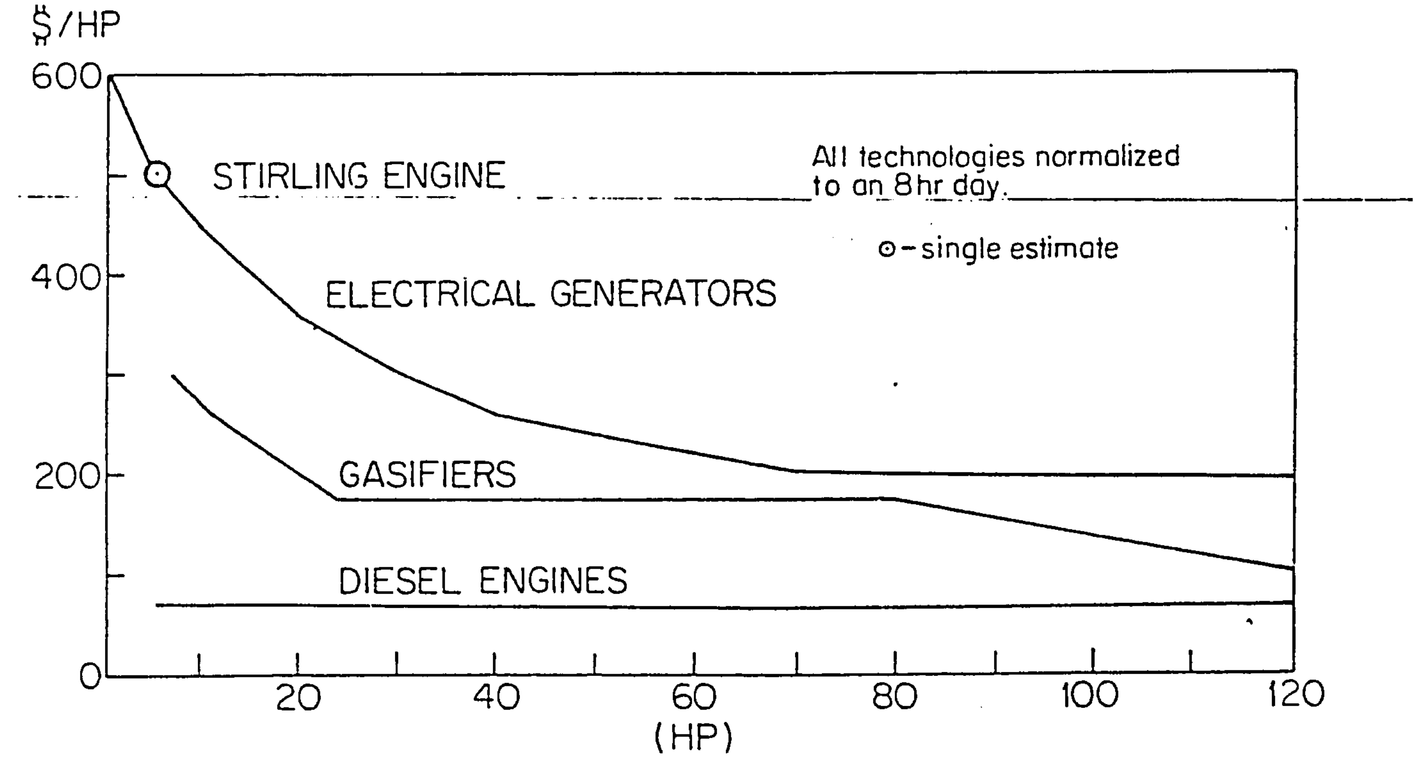

Fig. 2. Capital cost per HP of alternative power units

SOURCE: Seckler (1984)

Table 2. Distribution of rice production and rice hull generation in Indonesia in 1974

Region	Paddy area (mil ha)	Paddy production (mmt/yr)	Estimated rice hull (mmt/yr)
Java & Madura	4.72	18.30	4.60
Sumatra	1.91	8.27	1.60
Kalimantan	0.72	1.47	0.35
Sulawesi	0.67	1.93	0.45
Maliku & Irian Jaya	0.01	-	0.03
Bali & Nusa Tenggara	0.48	1.69	0.42
TOTAL	8.53	29.70	7.42

Reference: Harahap (1981).

Table 3. Cost comparison of diesel engine systems for the Philippines and Indonesia, 1984.

Item	Philippines	Indonesia
Cost of 15 hp engine ($)	2125	1125
Cost of diesel ($/l)	0.38	0.15
Rate of interest (%)	30	18
Repairs and maintenance/yr (% of initial cost of engine)	10	10
Operating hours (hrs/yr)	2000	2000
Annual Costs		
Fixed Cost/yr		
Depreciation (st. line)	425	225
Interest on capital	319	101
Repairs and maintenance	213	113
Total fixed cost	$957	$439
Variable Cost/year[a]		
Fuel used (liters)	9000	9000
Total var. cost	$3240	$3240
Total cost/year	$4377	$1789
Annual cost per horsepower-hour	$.1459	$.0597

[a]Assumptions

a) Fuel consumption: (milling operation)
   for diesel engine = 0.30 li/bhp-hr
   for rice hull = 1.25 kg/bhp-hr

b) size of engine - 15 hp

c) capacity of the mill - 750 kg/hr

d) operating hours:
   8 hours/day; 250 days/yr; 2,000 hours/yr

e) cost of 15 hp diesel engine
   Philippines - $2,125 Indonesia - $1,125

f) life of engine - 5 years

g) cost of fuel

	Philippine	Indonesia
Price/li diesel ($/li)	0.38	0.15
Price/kg rice husk ($/kg)	0.01	0.011

Table 4. Capital cost of the 15 hp diesel engine.

Item	Philippines	Indonesia
Capacity of engine (HP)	15	15
$/hp[a]	6	29
Cost of energy unit	0	0
Cost of engine	2125	1125
Total cost	2125	1125
Estimated engine life (years)	5	5
Rate of interest (%)	30	18
Annual cost of energy unit ($)	0	0
Annual cost of engine ($)	956	438
Total annual equipment cost ($)	956	438
Total annual variable cost ($)	3240	1350
Total annual cost ($)	4376	1789
HPH per year	30,000	30,000
Capital cost/HPS ($/HPH)	$.1459	$.0597

[a] See Appendix Table A.1

Table 5. Cost of energy using diesel.

Item	Philippines	Indonesia
Energy unit	fuel-liter	fuel-liter
Kcal/unit[a]	9000	9000
Efficiency rating of fuel	1.0	1.0
Kcal per fuel/unit	9000	9000
Power conversion efficiency	0.30	0.30
Kcal power/unit fuel	2700	2700
Liters fuel/HPH[b]	0.2374	0.2374
Energy cost/HPH ($)		
Diesel @ .45/li	0.1068	0.1068
@ .40/li	0.0949	0.0949
@ .35/li	0.0830	0.0830
@ .30/li	0.0712	0.0712
@ .25/li	0.0594	0.0594
@ .20/li	0.0475	0.0475
@ .15/li	0.0356	0.0356
@ .10/li	0.0237	0.0237

[a]Taken from Seckler (1984).

[b]HPH = 641 Kcal

Therefore: $\text{unit/HPH} = \frac{641}{2700} = 0.2374$

Table 6. Capital cost of 15 hp gasifier - diesel engine system.

	Philippines	Indonesia
Capacity of engine (HP)	15	15
$/HP[a]	48	17
Cost of energy unit ($)	1615	665
Cost of engine ($)	2125	1125
Total cost ($)	3740	1790
Estimated life of unit and engine (years)	5	5
Rate of interest (%)	30	18
Annual cost of unit	727	259
Annual cost of engine	956	438
Total annual equipment cost ($)	1683	697
Total annual variable cost ($)	1420	694
Total annual cost ($)	3103	1391
HPH per year	30000	30000
Capital cost/HPH ($/HPH)	.1034	.0464

[a]See Appendix Table A-1.

Table 7. Cost of energy using rice husk gasification.

Item	Philippine	Indonesia
Energy unit	rice husk-kg	rice husk-kg
Kcal/unit[a]	3482	3482
Efficiency to fuel	0.70	0.70
Kcal fuel/unit	2438	2438
Power conversion efficiency	0.30	0.30
Power-Kcal/kg	731	731
Unit/HPH[b]		
Rice husk (kg/.7 HPH)	.6138	.6138
Diesel (li/.3 HPH)	.0855	.0855
Energy cost ($/HPH[c])		
Rice husk	.00920	.00675
Diesel	.03249	.01283
Total	.04169	.01958

[a]Rice husk contains 6,300 BTU/lb or 3482 Kcal per kg.

[b]Diesel fuel has a rating of 1.0

For rice husk: 70:30 Husk/diesel fuel combination

HPH = 641 Kcal
0.7 HPH (449 Kcal) for gasifier

kg/HPH = 449 = 0.6138

For diesel: Value adjusted from Seckler (1984, p. 33)
li/HPH = .2849 li/HPH x .3 = .0855

[c]The following cost/unit were used:

	Philippines	Indonesia
price of diesel ($/li)	0.38	0.15
price of rice husk ($/kg)	0.015	0.011

Table 8. Cost effectiveness of alternative energy resources.

	Diesel		Gasifier-Diesel	
	Phil.	Indonesia	Phil.	Indonesia
Energy cost/unit ($/HPH) (Fr. Table 7 & 8)				
Diesel	0.0902	0.0356	.0325	.0128
Rice husk			.0092	.0068
			.0417	.0196
Capital cost ($/HPH) (Fr. Table 4 & 6)				
Diesel	0.1459	0.0597		
Rice husk			0.1034	0.0464
Total cost/unit ($/HPH)				
Diesel	0.2361	0.0953		
Rice husk			0.1451	0.066
AET/diesel				
Rice husk			0.61	0.69

Notes: The analytical approach used is described in detail in Seckler (1984). All figures are expressed in $/HPH and include both the fixed (investment) and variable costs for diesel engine and rice husk gasifier systems operating in Indonesia and the Philippines. The Appropriate Energy Technology (AET) is compared with the diesel alternative by means of a ratio. If the ratio is greater than one, the investment is not viable. Ratios of less than one are viable and indicate the degree of overall advantage of the AET compared with the diesel alternative.

Table 9. Sensitivity analysis for Philippines.

	Varying prices of gasifier unit		
	$1000	$1615	$4500
<u>Fixed</u> <u>cost</u>			
Depreciation	200	323	900
Interest	150	242	675
Repairs and replct.	100	162	450
TFC	450	727	2025
<u>Variable</u> <u>cost</u>			
Rice husk	394	394	394
Diesel	1026	1026	1026
TVC	1420	1420	1420
Total cost/year	1870	2147	3445
Capital cost/HPH	.0623	.0716	.1148
Energy cost/HPH	.0417	.0417	.0417
Total cost/HPH	.104	.1133	.1565
Capital cost/unit of diesel	.2361	.2361	.2361
AET/diesel	.44	.48	.66

Table 10. Sensitivity analysis for Indonesia.

	Varying prices of gasifier unit		
	$665	$1000	$3000
<u>Fixed cost</u>			
Depreciation	130	200	600
Interest	60	90	270
Repair and replct.	66	100	300
TFC	259	390	1170
<u>Variable cost</u>			
Rice husk	289	289	289
Diesel	405	405	405
TVC	694	694	694
Total cost/year	953	953	1864
Capital cost/HPH	.0318	.0361	.0621
Energy cost/HPH	.0196	.0196	.0196
Total cost/HPH	.0514	.0557	.0817
Capital cost/unit diesel	.0953	.0953	.0953
AET/diesel	.54	.58	.86

Appendix A-1

Case 1. Engine is operated on 100% diesel fuel

Diesel fuel cost = consumption/hour x no. of hours operated/year x price/li of diesel

Philippines = 4.5 x 2,000 x 0.38 = $3420/yr.
Indonesia = 4.5 x 2,000 x 0.15 = $1350/yr.

Case 2. Engine is operated on 100% rice husk (hypothetical)

Cost of rice husk = consumption/hr x no. of operating hrs/yr x price per kg.

Philippines = 1.25 x 15 x 2,000 x 0.015 = $562.50/yr
Indonesia = 1.25 x 15 x 2,000 x 0.011 = $412.5/yr

Case 3. Engine is operated on 70:30 fuel husk: diesel mixture

Rice husk - 1.25 kg/HPH
Diesel - 0.30 li/HPH

Diesel fuel cost

Philipines = .30/HPH x .3% diesel x 2,000 x 0.38 = $1026.00/yr
Indonesia = .30/HPH x .3% diesel x 2,000 x 0.15 = $405.00/yr

Cost of rice husk

Philippines = .7% husk x 1.25 x 2,000 x 0.015 = $394.00/yr
Indonesia = .7% husk x 1.25 x 2,000 x 0.011 = $289.00/yr

Appendix A-2

Fuel requirements to mill 1500 mt (750 kg/ha x 2,000 hr/yr) of paddy/yr using alternative fuel sources.

Using diesel fuel

```
(1,500,000 kg)      15 HPH              0.30 li
               x [-------]     x    [--------]    =   9,000 li
                  750 kg/hr            HPH
```

Using rice husks

```
(1,500,000 kg)       15 hp-hr        [1.25 kg]      =    37,500 kg
               x [---------]    x
                    750 kg
```

```
1,500,000 kg paddy -> (20%)   =  300,000 kg husks
                      (22.5%) =  337,500 kg husks
```

If 100% diesel:

9,000 li x $0.38/li = $3,420/yr operating cost in the Phil.

9,000 li x $.015/li = $1350/yr operating cost in Indonesia.

If rice husk

37,500 kg x $0.015/kg = $562/yr operating cost in the Phil.

37,500 kg x $0.011/kg = $412/yr operating cost in Indonesia.

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ANNEXURE 8

AMENDMENT No. 2

CONTRACT BETWEEN THE PEOPLES REPUBLIC OF BANGLADESH AND IRRI FOR TECHNICAL SERVICES FOR THE RICE RESEARCH AND TRAINING PROJECT PHASE II

Host Country Contract No.388-0051-02-A2-HCC

AMENDMENT NO.2

TO THE

CONTRACT BETWEEN

THE GOVERNMENT OF THE PEOPLE'S REPUBLIC OF BANGLADESH

ACTING THROUGH

BANGLADESH RICE RESEARCH INSTITUTE

AND

THE INTERNATIONAL RICE RESEARCH INSTITUTE

FOR

TECHNICAL SERVICES FOR THE RICE RESEARCH AND TRAINING PROJECT

PHASE II

JANUARY , 1986

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The Contract between the Government of the People's Republic of Bangladesh acting through the Bangladesh Rice Research Institute and International Rice Research Institute, is hereby amended by this AMENDMENT NO.2 as follows:

1. Section 2.01(b) is deleted in its entirety and the following is inserted in lieu thereof:

   The effective date of this Contract will be the date of last signature to it, and the estimated completion date of work described in Appendix A, including final report(s) under this Contract, will be June 30, 1987. Allowable costs incurred from June 6, 1981, to the effective date of the Contract are eligible for reimbursement under this contract in accordance with the applicable provisions of this Contract subject to the limitations set forth in Article III. The Contractor will be reimbursed for costs incurred from June 6, 1981, the effective date in performing services hereunder in accordance with the applicable provisions of this Contract subject to the limitations set forth in Article III, Sections 3.01(a) and 3.05(b) and (c).

2. Section 3.01(a) is deleted in its entirety and the following is inserted in lieu thereof:

   Based upon the estimated budget in Appendix C the maximum amount payable under this contract (including the Consultant's fee of $464,227) is $6,227,475 which may not be exceeded unless the contract is amended to increase the maximum amount. The total amount hereby committed and obligated by USAID for this activity is $3 million, which is estimated to cover costs of Services incurred from June 6, 1981 to June 30, 1987. This amount may not be exceeded during such period unless this Contract is amended to increase the amount. The Contractor shall continue the Services initiated on June 6, 1981, promptly and provide the Services during the foregoing period for which AID funding has been committed hereunder. The Contractor will furnish services, subject in all cases to the continued need for services, satisfactory performance by the parties hereunder, the availability of additional funds, and mutually agreeable budgets and Scope of Services.

3. Section 3.01(b) is deleted in its entirety and the following is inserted in lieu thereof:

   By signature of the contract the IRRI hereby requests AID to issue a Letter of Commitment in U.S. Dollars in favor of the IRRI. The Letter of Commitment shall be in the name of the IRRI and shall expire on February 4, 1988.

4. Section 3.02(c) is deleted in its entirety and the following is inserted in lieu thereof:

   The following budget establishes limitations for the reimbursement of costs for the line items listed therein. The Contractor may make adjustments up to a maximum of 15 percent

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among the listed items as provided in Section 3.06(a) provided that such adjustments do not exceed the amount obligated for in the Contract.

		Dollars
1.	Regional Stations	$ 476,711
2.	Vehicle Procurement	231,496
3.	Scientific Equipment Mech. Supplies	690,084
4.	Manpower Development	1,701,660
5.	Expatriate Scientists	1,796,719
6.	Short Assignment Specialists	286,188
7.	Domestic and Int'l Travel	179,232
8.	Other Program Costs	10,883
9.	Contingency	-
10.	IRRI Service Charge	464,227
11.	Dhaka Support Office Operations	390,275
	Total	$ 6,227,475
	USAID Support	$ 3,000,000

5. Section 3.05(a) is deleted in its entirety and the following is inserted in lieu thereof:

AID established disbursement and procurement procedures will be followed for AID financed activities. Goods and services procured with USAID funding shall have their source, origin and nationality in The United States, Code 941 countries or in Bangladesh. IRRI is required to submit financial reports and statements which indicate compliance with USAID source and origin procurement requirements.

* (a) All USAID-financed goods covered by this contract which are transported on ocean vessels shall be transported on privately owned U.S. flag commercial vessels to the extent they are available at fair and reasonable rates for U.S. flag commercial vessels. If such flag vessels are not available, the Supplier may request a waiver from the Office of Commodity Management, AID, Washington, D.C. 20523.

(b) When shipment is made under a through bill of lading issued by an eligible flag carrier, AID will finance costs incurred on vessels under flag registry of any free world country if the costs are part of the total cost paid to the eligible flag carrier.

The USAID grant is $3,000,000. Other financial contributors to the total project are the Government of Australia, the Government of Canada, the Ford Foundation and the Government of Bangladesh. All international donor funds in support of the project will be managed by IRRI.

6. Appendix A, page 3 is deleted in its entirety and the following is inserted in lieu thereof:

development support, especially in the areas of improved: (a) crop varieties and cultivation practices; (b) soil and water management practices; (c) pest control techniques; and (d) effective fertilizer use.

The establishment of an effective agricultural research system will be achieved through the development of core research programs within a "farming systems research" framework. Scientists in the multidisciplinary teams will work at the farm level in cooperation with farmers and extension workers to: (a) identify production constraints as a basis for further research; (b) develop new technologies at stations or in the field; (c) conduct field trials of these new technologies at stations or in farmers' fields; (d) evaluate new varieties and practices in pilot production programs; (e) demonstrate these new technologies to farmers and extension workers with attention to in-service training; and (f) monitor the rate of adoption by farmers and problems they encounter in so doing.

To motivate closer collaboration of research scientists among themselves and with farmers in the field, the following are some of the mechanisms to be employed by the project:

a) multidisciplinary research "task forces" to address specific cropping system constraints;

b) greater autonomy to regional stations to conduct region specific research with their own research budgets and manpower.

USAID has provided grant funds for BRRI's Phase II Project effective June 6, 1981 for financing the following inputs to be provided by the host country contract:

a) The host country contract will provide partial support toward total technical assistance requirements: 258 person months of long-term and 62 person-months of short-term technical assistance.

b) The host country contract will also provide partial support toward BRRI's total training program: 13 Ph.D./U.S. and third country; 32 M.Sc./third country; 4 Ph.D. and 12 M.S. programs in country; 97 participants in IRRI short-term courses; and 4 in-country research management and methodology/administration courses. There will also be farmer field days and other specialized farmer training in connection with the development of rice production strategy and cropping systems approaches.

III. Technical Services to be Provided by IRRI

IRRI will provide the following services:

a) Provision of a total of 320 person months of Technical Assistance: 258 person months of long .erm and 62 person months of short-term Technical Assistance;

b) Procurement of commodities; and

c) Supervision of training program.

7. Appendix A, pages 4 and 5 are deleted in its entirety and the following is inserted in lieu thereof:

Specialists

. Five Specialists will be provided in the following areas:

	Specialist	Person Months
A)	Research Systems Management/Team Leader	74
B)	Off-Station Research Specialist	56
C)	Agricultural Economist	36
D)	Deepwater Rice Breeder	62
E)	Rice Farming Systems Specialist	30
	Total:	258

a) Research Systems Management/Team Leader

The Specialist is the principal representative of IRRI in Bangladesh and has overall administrative supervision of IRRI's involvement in the Project. He works closely with and is responsible to the BRRI Director General and assists the BRRI Directors of Research, Administration and Communications and BRRI Divisional Heads in securing more effective use of physical and human resources for rice research and training through more efficient program planning, implementation, monitoring and evaluation. He helps BRRI plan and operate a scientific manpower training development program that includes short term training and graduate study both abroad and in country. He also helps to strengthen relationships with IRRI, other research institutes and donor agencies, advise on budget control and financial management, strengthen linkages between research and extension programs and improve the communication and training competence of the research system network.

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b) Off-Station Research Specialist

The Rice Production Specialist works with BRRI to help develop, organize, and implement inter-disciplinary rice-based research programs on farmers' fields. The Specialist assists staff at the five BRRI regional research stations design, conduct, and evaluate on-farm field trials for varietal selection, improved fertilizer practices, weed control methods, pest management techniques, and soil/water management practices. The Specialist also helps BRRI devise off station research data collection and data processing systems, plan appropriate analyses and report and publish relevant results. The Specialist assists BRRI with coordination of its various task force off station testing programs and in arranging appropriate cooperative relationships with other research organizations and the Department of Extension headquarters and field staff. The Specialist is based in the Applied Research Division at BRRI.

c) Agricultural Economist

The Agricultural Economist will assist BRRI plan and investigate constraints to increased rice production. The Specialist will advise BRRI and the Marketing Bureau plan and conduct a nationwide study of the existing rice marketing system. The Economist will assist the BRRI Economics and Statistics Divisions plan computer installations; order, install equipment and conduct initial staff orientation training; and encourage establishment of appropriate work procedures to guide initial operations of the enhanced P.C. type computers that will be imported. With assistance from IRRI, an initial set of software will be imported and installed.

d) Deepwater Rice Breeder

The Deepwater Rice Breeder assists BRRI in developing high yielding rice varieties suitable for Bangladesh's various ecological environments subjected to flooding. The Specialist advises and assists BRRI with the development, management, and monitoring of varietal screening programs. Further, the Specialist develops techniques and secures equipment to facilitate efficient management of breeding plots, systems for safely storing seed while maintaining purity and viability and methods for compiling and interpreting field data. The Specialist works closely with concerned BRRI station scientists planning and conducting advanced line trials and in arranging proper trials to justify formal release of new deep water rice varieties to farmers. He is based in the rice breeding division and directly functions as a deep water rice breeder.

e) Rice Farming Systems Specialist

The Rice Farming Systems Specialist helps plan and conduct cropping systems research, organize findings and associated component technology into extension teaching materials, in order to facilitate and conduct on farm multilocation trials, pilot production and production programs. He works with and assists BRRI scientists engaged in rice farming systems research and associated technology transfer to agencies and organizations performing extension education work with rice farmers.

He identifies potential collaborating government and voluntary agencies and organizations performing extension functions and helps BRRI develop appropriate working agreements and defining mutually helpful roles and responsibilities in implementing rice farming systems technology transfer. He assists BRRI scientists devise and test teaching materials for training collaborating professional workers to effectively deliver key information and timely support services to potential farmer adopters. The Specialist helps edit and publish technical bulletins and newsletters to disseminate research findings to Extension Subject Matter Specialists for use in training village extension workers and rice farmers. He helps plan studies to identify constraints and inhibitors preventing farmer adoption of more intensive land use cropping patterns and associated recommended production practices and helps devise approaches for overcoming these identified difficulties.

He encourages and assists BRRI scientists use various communications means such as radio, TV, village rice school, etc. for informing concerned agri-business investment opportunities associated with provision of timely inputs and sale of farmer surplus output.

V. Short-Term Consultants

IRRI will arrange for 62 person months short-term technical assistance to carry out its responsibilities with particular reference to the development of an inter-disciplinary research program focused on cropping systems, research extension linkages, and strengthening of BRRI's institutional and scientific capacities for developing and delivering appropriate production technologies to farmers.

VI. Training Program

The Contractor will cooperate with the BRRI Director General and other staff in formulating plans and activities for professional development of scientists, trainers, extension workers, and farmers in the concepts and skills of improved rice production research and technology transfer, core research disciplines, and inter-disciplinary team research efforts directed toward developing environmental-specific rice varieties and cultural practices.

Planned training activities which USAID's partial contribution will support (in accordance with Appendix A, page 3), are outlined below:

13 Ph.D. degree programs in third countries or U.S.

32 M.Sc. degree programs in third countries or U.S.

4 Ph.D. degree programs in-country

12 M.Sc. degree programs in-country

97 individuals at IRRI short-term courses

4 in-country training programs in research management and methodology/administration for BRRI junior scientists.

8. Appendix A, page 6 is deleted in its entirety and the following inserted in lieu thereof:

The third-country programs will focus on the following subject areas:

Long-Term Third Country

Subject Areas	M.S.Programs	Ph.D. Programs
Applied Research and Training	3	1
Agricultural Engineering	3	1
Agronomy	3	1
Breeding	8	2
Economics	1	1
Entomology	1	1
Pathology	2	1
Physiology/Microbiology	2	1
Rice Cropping Systems	2	3
Rice Technology	2	0
Soil Chemistry	2	0
Statistics	0	1
Planning and Evaluation	1	0
Station Management	2	0
Total:	32	13

Short-Term Third Country

Subject Areas	Number of BRRI Scientists
Station Management	4
Applied Research Training	8
Varietal Development	4
Pest Management	3
Irrigation/Water Management	24
Rice Cropping Systems	18
Rice Physiology	1
Rice Technology	4
Seed Management	2
Editing	2
Economic Analysis & Interpretation	2
Library Operations	1
Farm Management	3
Statistics & Computer Operation	2
Soil Fertility Management	3
Support Services	6
Agricultural Engineering	5
to be identified	5
Total:	97

9. Appendix C is deleted in its entirety and the following is inserted in lieu thereof:

Revised Budget of the BRRI/IRRI Project

(May 1, 1981 -June 30, 1987)

	Actual Expenditures 5/01/81 to 3/31/85	Estimated 4/1/85 to 6/30/86	Expenditures 7/01/86 to 6/30/87	Revised Budget
1. Regional Stations	$ -	$ 350,000	$ 126,711	$ 476,711
2. Vehicle Procurement	121,396	67,500	42,600	231,496
3. Scientific Equipment Mech. Supplies	490,084	100,000	100,000	690,084
4. Manpower Development	1,021,298	310,000	370,362	1,701,660
5. Expatriate Scientists	1,073,069	505,000	218,650	1,796,719
6. Short Assignment Specialists	103,488	91,500	91,200	286,188
7. Domestic and Int'l travel	86,657	55,000	37,575	179,232
8. Other Program Costs	883	4,000	6,000	10,883
9. Contingency	-	-	-	-
10. IRRI Service Charge	274,285	107,635	82,307	464,227
11. Dhaka Support Office Operations	239,937	97,338	53,000	390,275
Total:	$3,411,097	$1,687,973	$1,128,405	$6,227,475

10. All other terms and conditions of the Contract shall remain in full force and effect.

In Witness Whereof, the parties do hereby signify their agreement to this Amendment, effective on the date of the last signature, by having their duly authorized representative affix signature hereto.

For and on behalf of
The Government of the People's
Republic of Bangladesh

By: M.A. Mannan
M.A. Mannan
Director General
Bangladesh Rice Research Institute

Date: Feb 4, 1986

Witness: Ziauddin Ahmed Khan

For and on behalf of
The International Rice
Research Institute

By: M.S. Swaminathan
M.S. Swaminathan
Director General
International Rice Research Institute

Date: Jan 26, 1986

Witness: Frank W. Sheppard Jr.